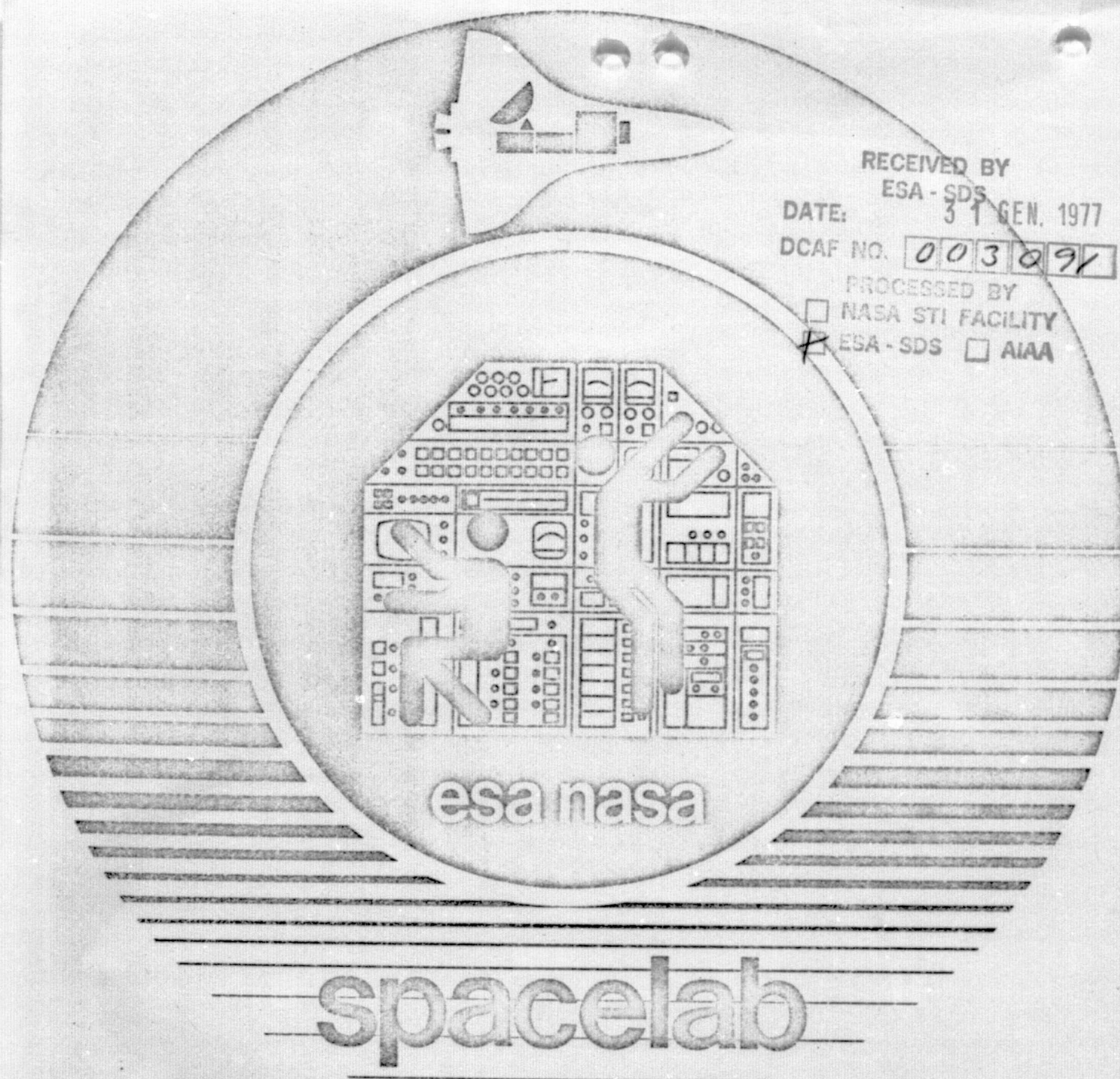


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NASA

National
Aeronautics and
Space
Administration



98569

SPACELAB PROGRAMME OVERVIEW

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NATIONAL AERONAUTICS AND SPACE
ADMINISTRATION

B. DELOFFRE
DIRECTOR OF SPACELAB PROGRAMME
EUROPEAN SPACE AGENCY

13TH SPACE CONGRESS
COCOA BEACH, FLORIDA

7 APRIL 1976

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INTRODUCTION

The Spacelab Programme is a challenge in many respects. When the Spacelab Agreements were signed in 1973, for the first time Europe and the U.S. had decided to jointly develop, build and operate a Space system. It is also a challenge because the Spacelab concept is being developed practically in parallel with the Space Shuttle and at the same time as the operational approaches and the requirements from the users point of view evolve. Never before had a space programme so many interface conditions to fulfil as Spacelab does in terms of technical, financial and schedule requirements.

Since the signature of the agreements, the Spacelab Programme has come a long way. The completion of the Subsystem Requirements Review conducted in 1975 signifies that the programme has passed the definition and documentation phase and has entered into the detail design and hardware development phase (Figure 1).

The development of the first Spacelab is more and more regarded as the first phase of a joint programme to be followed in the future by the utilization of the Spacelab/Space Shuttle system, the follow-on production and the extension of the Spacelab capabilities beyond the present concept.

It is from this perspective that both ESA and NASA are now looking at the Spacelab/Shuttle Intergovernmental Agreement and the related NASA/ESA Memorandum of Understanding. It is now possible to see the outlines of the future being pressed sharply into the present (Figure 2).

The objectives of this joint venture are clear (Figure 3). We want to provide a laboratory and observation facility in space to as many experimenters of various disciplines as possible at reasonable cost thus facilitating research and application experiments in space with more direct involvement of the experimenters in all phases of space missions.

In this report we summarize the current status of our activities for reaching these objectives. Starting from the programme requirements (Figure 4) which are given here for completeness sake, the report

will describe the basic Spacelab concept, the programmatic aspects of the programme and some considerations concerning payload integration and payload operations.

SPACELAB CONCEPT

As a result of the intense activity over the past year on the design of the Spacelab itself, the Spacelab as a system is emerging from its conceptual phases to firm system configuration. As a basic reference to the Spacelab system, Figure 5 displays the three modes in which the Spacelab can be configured, namely the pressurized module, the pallet-only mode and the combination pressurized module and pallet assembly.

In Figure 6 we see the external features of both the pressurized module and the pallet. It can be noted that the major changes since our last presentation before this group are chiefly in the revised tunnel configuration, the new utility interfaces in which the utility bridges have been eliminated in favour of cable connects and in a change in the igloo from a horizontal position in front of the pallet to a vertical position in front of the pallet.

In Figure 7 we see the inboard profile of the Spacelab pressurized module as it exists today. It will be noted here that certain changes have also been made, these are primarily in the increased size of the feedthroughs, in the equipment racks and certain avionics designs and airlock configurations. These will be described in more detail in a later paper.

Figure 8 shows, how the major elements of the Spacelab itself fit together. It is easily seen by this figure that the modular design of the Spacelab permits a tremendous flexibility in its utilization; it is this flexibility that gives to Spacelab its unique characteristics for the users.

In Figure 9 we see three representative Spacelab flight configurations. These are included primarily to give some feel for the dimensions of these configurations. We will not describe them in detail except to

point out that the flexibility of the modular concept is very evident by the configurations shown here.

Figure 10 shows the current concept for the Instrument Pointing System (IPS). IPS is part of the Spacelab programme. At the present time, the formal agreement to proceed with the development of the IPS is still pending. We expect that the approval by the heads of the two agencies will be obtained very shortly. Our current plan is that the delivery of the first flight unit of IPS will occur in February 1980 and that it will be flown on board the second Spacelab flight.

In Figure 11 we see the tunnel configuration for both the forward and aft locations of Spacelab. The tunnel is a development of NASA and at the present time we are on schedule with our plans for procurement of the tunnel.

I would like to refer briefly to the capability of the Spacelab to support the user. In Figure 12 I have summarized the various support parameters of interest to users. Weight, volume, power, energy, data recording available to the users have been tentatively determined. It should be noted here that some of these numbers are subject to specialized requirements such as the mission duration. The provision of support to the user for missions in excess of seven days, must come from available payload weights for the user.

One of the key elements of concern to both ESA and NASA is the approach to safety in the Spacelab Programme.

Figure 13 describes this approach, and as can be seen, we are attempting to direct our attention to those areas of safety which are of concern not only to the crew, but also to the user. In particular, the material selection requirements are of concern to us since as far as the experiments and payloads are concerned, it is our intent that materials flown in the laboratory will not only be compatible with the environmental conditions in Spacelab, but also with the crew, without at the same time requiring unique materials that would drive up the cost of experiment and payload development.

SPACELAB PROGRAMMATICS

With respect to the financial situation and schedule considerations of the Spacelab program, it can be stated that both are in a sound condition. Before I address these two areas, however, I would like to discuss the breakdown of responsibilities and contributions between ESA and NASA as they are agreed upon in the Memorandum of Understanding. Figure 14 shows these responsibilities. With respect to previous versions of this illustration, it should be noted that we are showing as an ESA responsibility the reproduction of follow-on flight units. This implies that NASA has essentially to come to a decision regarding the number of required follow-on flight units. We are in the process of negotiating this matter at the present time between our two agencies. Additionally, it should be noted, that ESA retains to itself, as it should, the integration of European experiments into not only its own Spacelab but into the joint Spacelab missions involving both agencies.

Figure 15 shows the Spacelab programme master schedule. This schedule is currently under review. At the present time the Preliminary Design Review is scheduled to take place in two increments, phase A portion in June, and a Phase B portion in October of this year. It is not considered that this change will have any impact on the delivery and flight dates of the overall schedule. Referring to Figure 16 it can be seen that a number of near term schedule milestones have been met. It is significant to note from this figure that we are on schedule and that the forecast milestones are being met essentially as planned.

Figure 17 and Figure 18 show a number of programme management organizational relationships. Figure 17 describes the approach to overall management of the Spacelab itself whereas Figure 18 refers to the relationship of the Spacelab programme to the users. I think it is worthwhile to note from these illustrations that close links have been established between the organizations at various levels. This assures that the capability of the laboratory will be closely atuned to the requirements of the users.

In Figure 19 we illustrate the responsibilities of the European industrial contractor team which comprises the prime contractor, ten co-contractors and numerous sub-contractors. It should be noted that 39 per cent of the

work is carried out under fixed price contracts.

Figure 20 displays the budget allocations and the distribution of funding among the member states in Europe for the Spacelab Programme.

Similarly in Figure 21 we see a breakdown of the funds for development and operational responsibilities of NASA.

In Figure 22 we show the Spacelab documentation tree, indicating the kinds of documents that have been established for the programme. Most of these documents are jointly controlled by NASA and ESA Transportation System.

PAYLOAD INTEGRATION / OPERATIONS

As the development of Spacelab matures and the date of the first Spacelab flight comes closer the need for planning the payload integration and operations activities become more important.

In Figure 23 we depict the kinds of user participation that we see for the Spacelab programme. This participation is divided into various levels, one which involves the individual users, another which involves a user organization.

The conclusion that we wish to leave with you with respect to this figure is that the user will have a more important involvement in the Spacelab programme with his experiment than in any other space programme to date.

In Figure 24 we show the Spacelab experiment / payload operations interfaces. Though this particular illustration appears to be rather complicated, what we are attempting to show here is the merging together of the experiments selection and development process with the payload integration activities. It will be noted that the SPICE group in Europe (Spacelab Payload Integration and Coordination in Europe) which is located at Porz-Wahn, Germany, is the primary organization for the integration and coordination of individual experiments. The individual experiments selected for development in Europe are integrated into the racks and through pre-Level III or Level III into the pallet and shipped to the payload integration center at KSC. There they proceed through Level III, Level II and Level I up to launch. Similarly, experiments developed by NASA programme offices flow through a NASA Level IV integration center which in the

case of missions 1 and 2 of the Spacelab is the Marshall Space Flight Center and hence to KSC where they are merged together with the European experiments.

Figure 25 shows this process in a more schematic sort of way. Principle Spacelab Mission 1/2 implementation responsibilities within NASA are the STS Management and Payload responsibilities at NASA Headquarters; Flight Operations at JSC; Ground and Logistics Operations at KSC; and Spacelab Programme Management Payload Mission Management, Logistics Management, and Software Integration at MSFC. In addition, the users will develop and operate their experiments and ESA plans to play a role in the pre-selection and training of European payload specialists.

will manage the European Payloads. Figure 26 shows the many varied and complex activities and interfaces involved in Spacelab lab operations. They will be described in detail as I proceed.

Figure 27, illustrates the payload mission planning elements/interfaces. Some of the major elements of Payload Mission Planning are depicted on the accompanying chart. User requirements and definition and the STS capabilities/constraints provide the basis for performing the payload mission planning. Payload Integration Requirements Analyses provides typically mass properties, crew activity elements, layouts and mission planning. Culmination of various efforts is anticipated to be in a Payload Definition Document (PFDD). Contents of the PFDD include typically: Payload/Experiments Definition, Requirements and Accommodation, Orbit Selection, Orbital Environment, Communications, Crew Activity Timelines, Subsystem Resource Requirements and Accommodation, Payload Requirements on STS Resources/Orbiter Attitude, Ground Support Requirements, etc.

Figure 28, illustrates the payload integration requirements definition elements/interfaces. The major payload integration requirements definition elements/interfaces activities are depicted on the accompany chart. The flight support analysis establishes the requirements and resources required to perform the conduct of the mission from onboard or from the ground. The experiments/systems compatibility analysis assesses experiment compatibility with Spacelab compatibilities/constraints, mission objectives, and with other experiments, objectives,

operations, and envelopes. The ground operations analysis identifies individual ground operations processing and support requirements for Spacelab/Payloads. These analyses feed each other and require interfaces with the User community, with the Mission Planning

13
14

operations, and envelopes. The ground operations analysis identifies individual ground operations processing and support requirements for Spacelab/Payloads. These analyses feed each other and require interfaces with the User community, with the Mission Planning activity, with ground and mission operations. The Mission Planning activity provides typically an activity timeline, power profile, a radiation history, etc. These integration analyses feed the PFDD and physical integration requirements documents. Subsequent charts will show tasks performed in each analysis.

Figure 29, the ground operations required to process and recycle Spacelab elements and associated Payloads are comprised of many varied and complex activities. The major activities are depicted on the accompanying chart. Physical integration is the pacing activity around which the others are planned. Provisions are being made for ample facilities and ground support equipment to accommodate the hardware processing events. A logistics system to efficiently maintain, transport and repair the operational Spacelab must be established. Quality, safety and engineering surveillance of all ground operations will be implemented. An adequate engineering base will be required to sustain the operational capability of the Spacelab elements, facilities, and support equipment. Since each activity is an integral part of the overall operational capability, thorough planning and scheduling will be required if the maximum operational capability is to be realized.

Figure 31, flight operations encompasses the activities for the operation of the Space Transportation System (STS) i.e., Shuttle/Spacelab, and the Payload. The STS and Payload functions may be executed onboard or from a ground support facility. Typical onboard functions include Spacelab resource management, command of the flight, flight safety, EVA, and experiment operation and maintenance, and experiment data observation for the Payload. Typical ground support functions include STS resource management support, flight plan integration, and data and communications management, and User support, science data management, and Payload activity scheduling for the Payload.

Figure 32, the flight crew composition required to perform the onboard STS and Payload activities consists of a Commander, Pilot, Mission Specialist, and one to four Payload Specialists. The principle responsibilities of the Commander and Pilot are command of the flight and the operation of the STS. The Mission Specialist and Payload Specialists are primarily concerned with the direction and performance of Payload operations.

Figure 33, ground support to the onboard activity is provided for both STS and Payload operations. The Payload Operations Center (POC) will provide direct support to Payload operations via the Payload Director and User support teams. Support to the STS will be provided by the Flight Director and the flight control team. Continuous coordination interface will be maintained between the STS Mission Control Center (MCC) and POC.

Figure 34, Spacelab data and communications systems include telemetry, voice, video, uplink photographic and specimens/samples. Data is retrieved both by electronic transmission during the test period and storage onboard Spacelab for retrieval after Shuttle landing. Specific data flow implementation within the basic system capability will be established on a mission basis. During onboard operations, data generated onboard Spacelab is transmitted by the Orbiter avionics system to the Tracking and Data Relay Satellite. (TDRS) ground terminal via the orbiting satellite. From the ground terminal the data is routed to the NASCOM interface for retransmission to the POC/facilities, utilizing domestic satellites for high-bit-rate data and terrestrial links for low-bit-rate data. Both data transmitted electronically and that retrieved upon Shuttle landing will be delivered to the users for data reduction, data analysis and archiving. All commands from the operations centers will be routed through the MCC at JSC for uplink to the Spacelab.

CONCLUSION

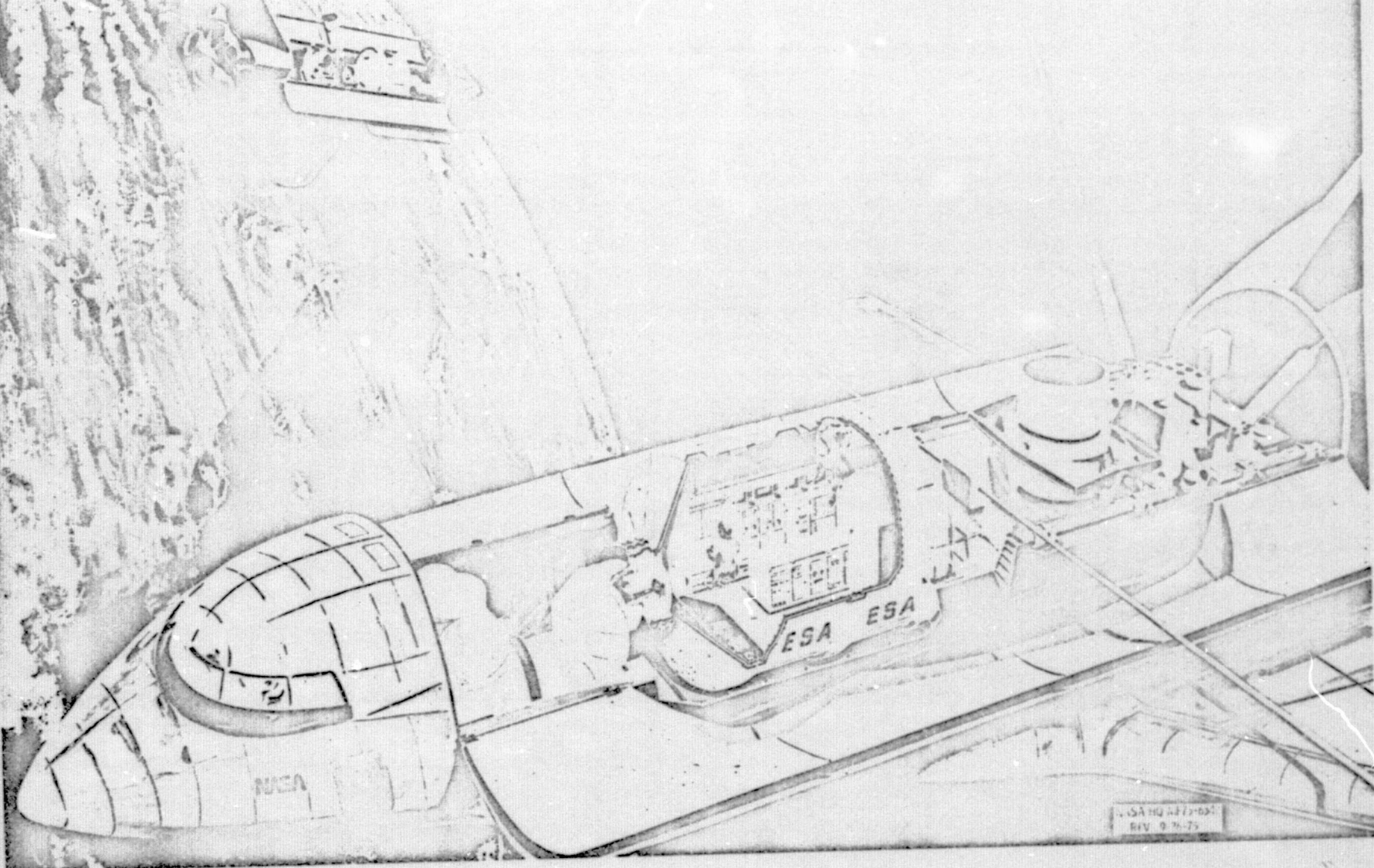
It has been demonstrated that there is no doubt that ESA and NASA are firmly on course with the development of Spacelab. We have demonstrated that our associations of the past few years show that we understand the roles, functions and activities of each organization very thoroughly, to the extent that problems that develop in complex programmes of this kind can be resolved. We look to the immediate future with confidence and full expectation that our major milestones will be met to the complete satisfaction of both parties. With respect to NASA and ESA plans for utilization of the Spacelab, we have made considerable progress. We are moving ahead with our initial plans for follow-on production and procurement.

In Figure 35, we show the initial plans for Spacelab follow-on procurement. As you can see, NASA has received a preliminary price proposal by ESA, and it is our expectation that an RFP for procurement will be issued by NASA before the end of this year.

The programme progress demonstrates that Spacelab is a firmly established part of the Space Transportation System.

SPACELAB

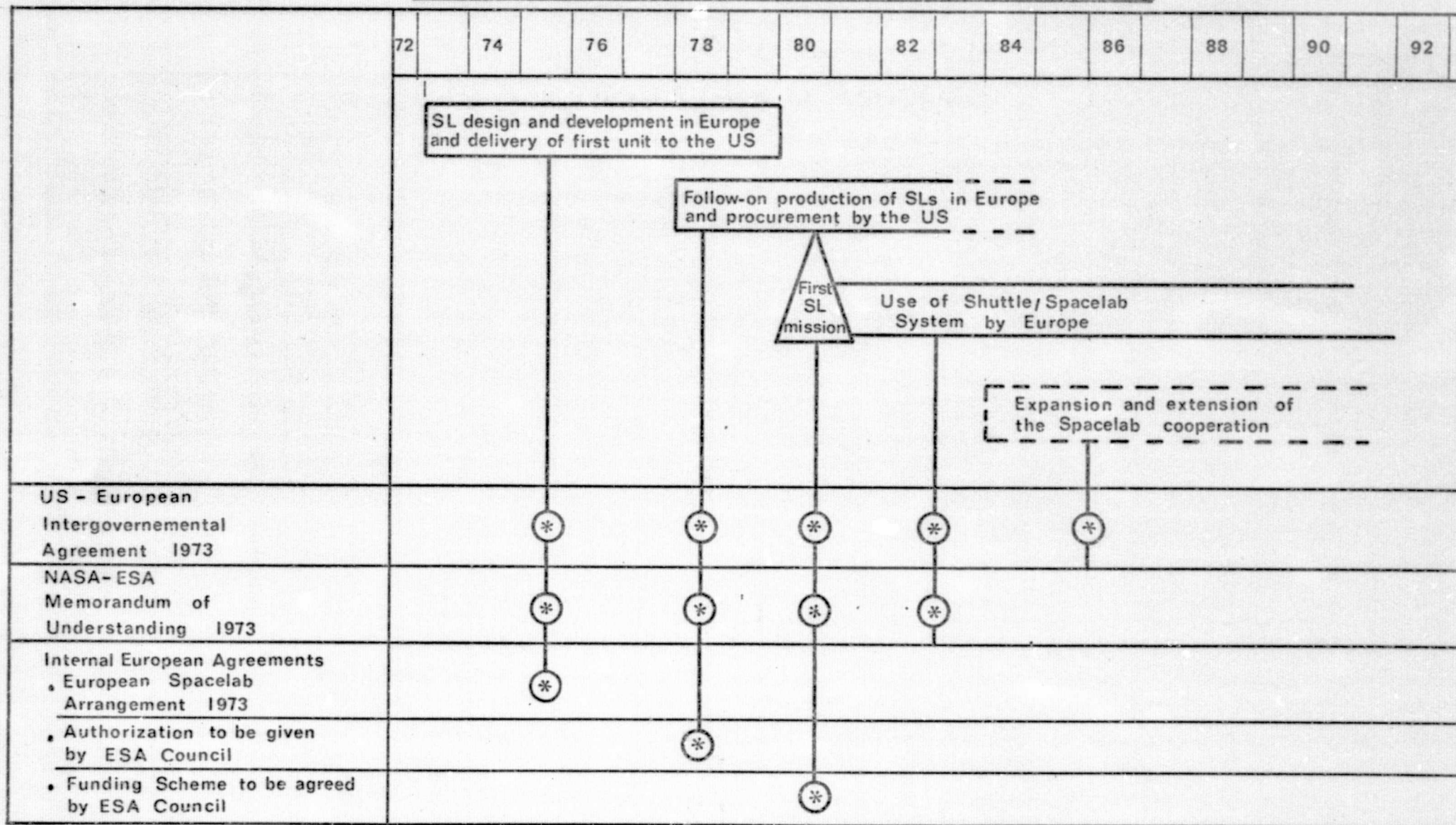
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THE SPACELAB PROGRAMME

A LONG TERM INTERNATIONAL COOPERATION

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MAJOR SPACELAB PROGRAMME OBJECTIVES

- TO PROVIDE TO A LARGE MULTIDISCIPLINARY USER COMMUNITY
A VERSATILE LABORATORY AND OBSERVATORY FACILITY
- TO REDUCE SIGNIFICANTLY BOTH THE TIME AND COST REQUIRED FOR
SPACE EXPERIMENTATION
- TO MAKE DIRECT SPACE RESEARCH POSSIBLE FOR QUALIFIED SCIENTISTS
AND ENGINEERS WITHOUT THE NEED OF FULL ASTRONAUT TRAINING



SPACELAB PROGRAMME REQUIREMENTS

- o PRE-DETERMINED FUNDING CEILING
- o DELIVERY OF FLIGHT UNIT EARLY-1979, ENGINEERING MODEL EARLY-1978
TOGETHER WITH ASSOCIATED GROUND SUPPORT EQUIPMENT
- o LOW OPERATIONS COSTS TO BE ENSURED
- o USER FLEXIBILITY TO BE PRESERVED
- o EXPERIMENT PAYLOAD WEIGHT 5000 TO 9000 KG
- o PROVISION FOR FOLLOW-ON PRODUCTION
- o FLIGHT DURATION 7 TO 30 DAYS
- o DESIGN LIFE 50 REUSES OR 10 YEAR LIFETIME
- o CREW OF 1 TO 4 PAYLOAD SPECIALISTS
- o COMPATIBILITY WITH SPACE SHUTTLE



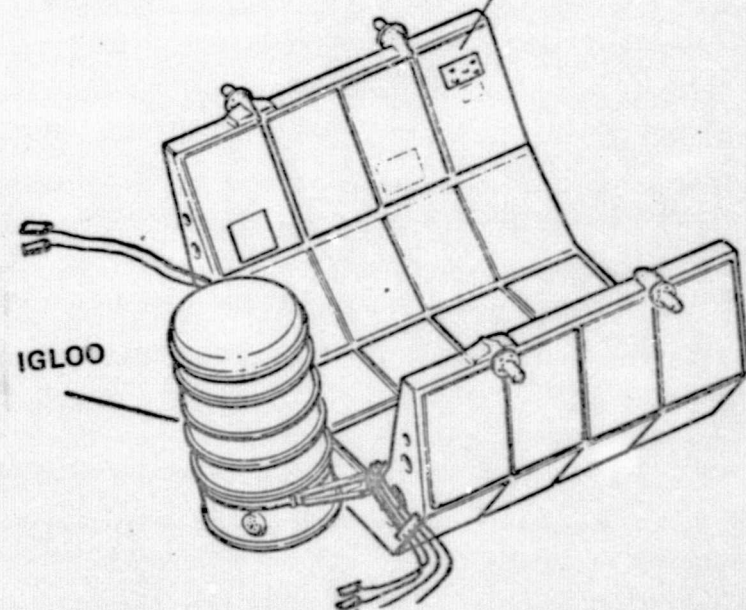
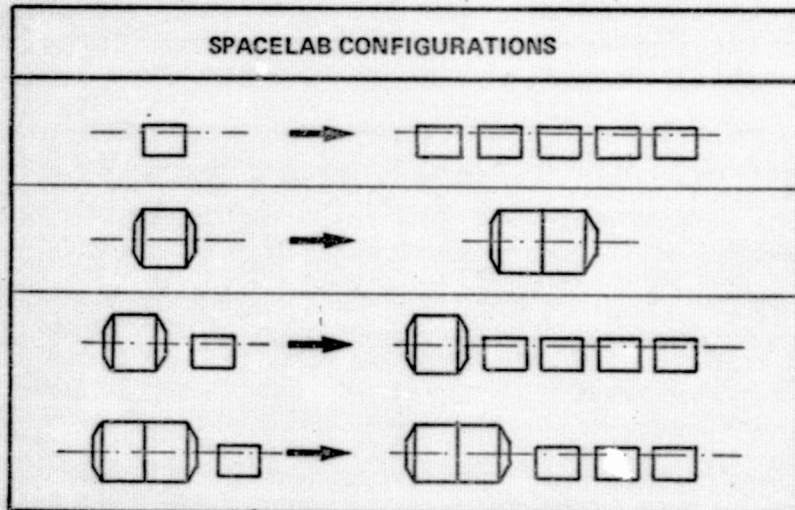
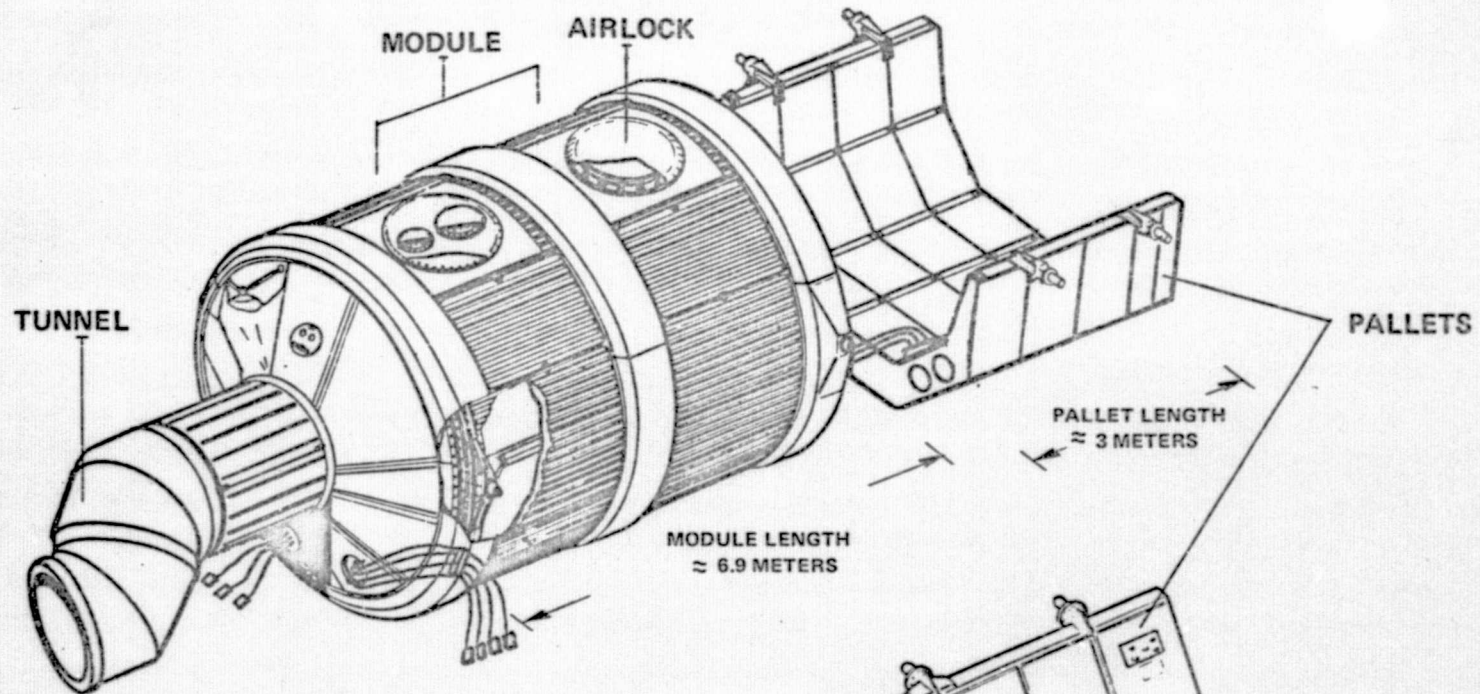
THE CONCEPT

PRESSURIZED MODULE

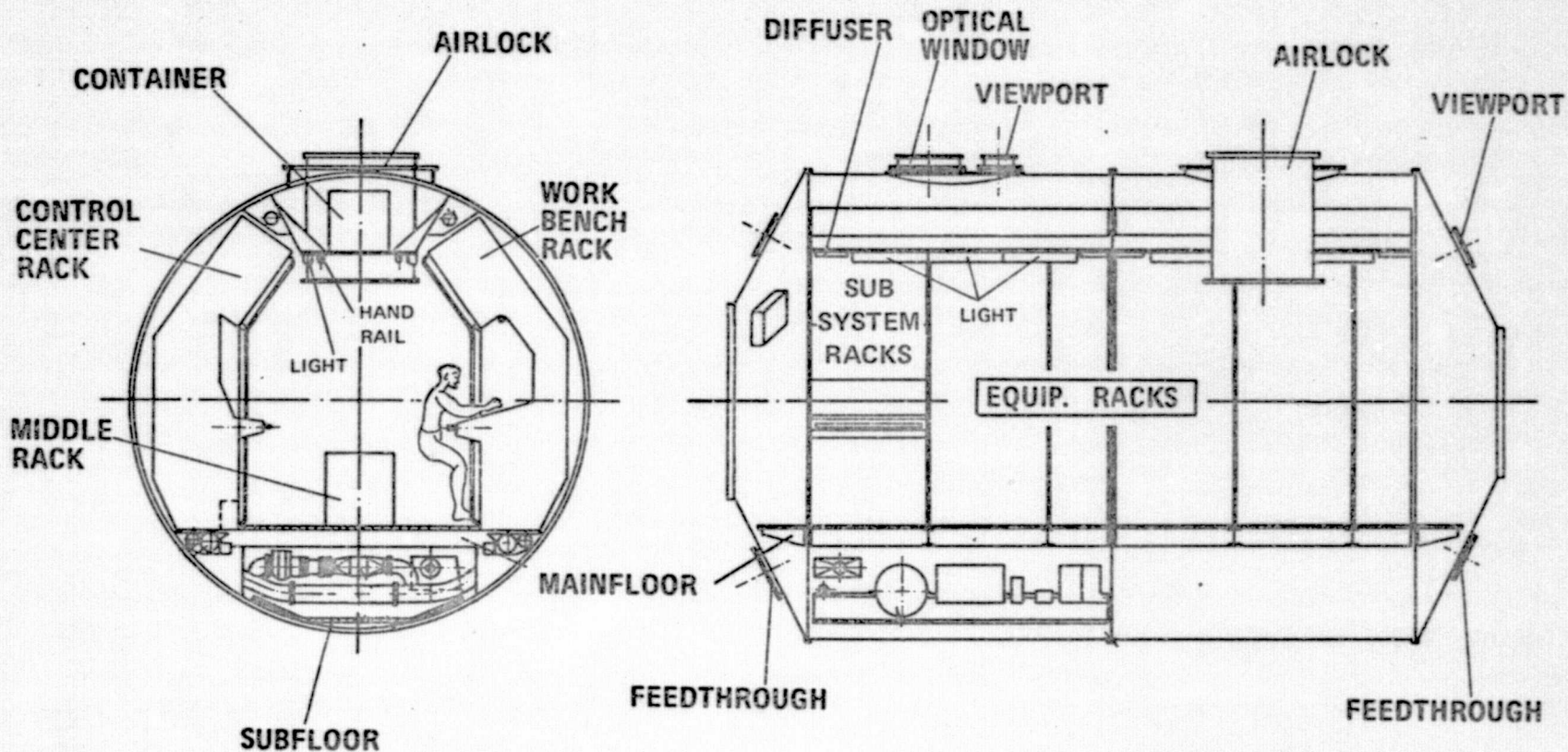
PALLET ONLY

PRESSURIZED MODULE AND PALLET

SPACELAB EXTERNAL FEATURES

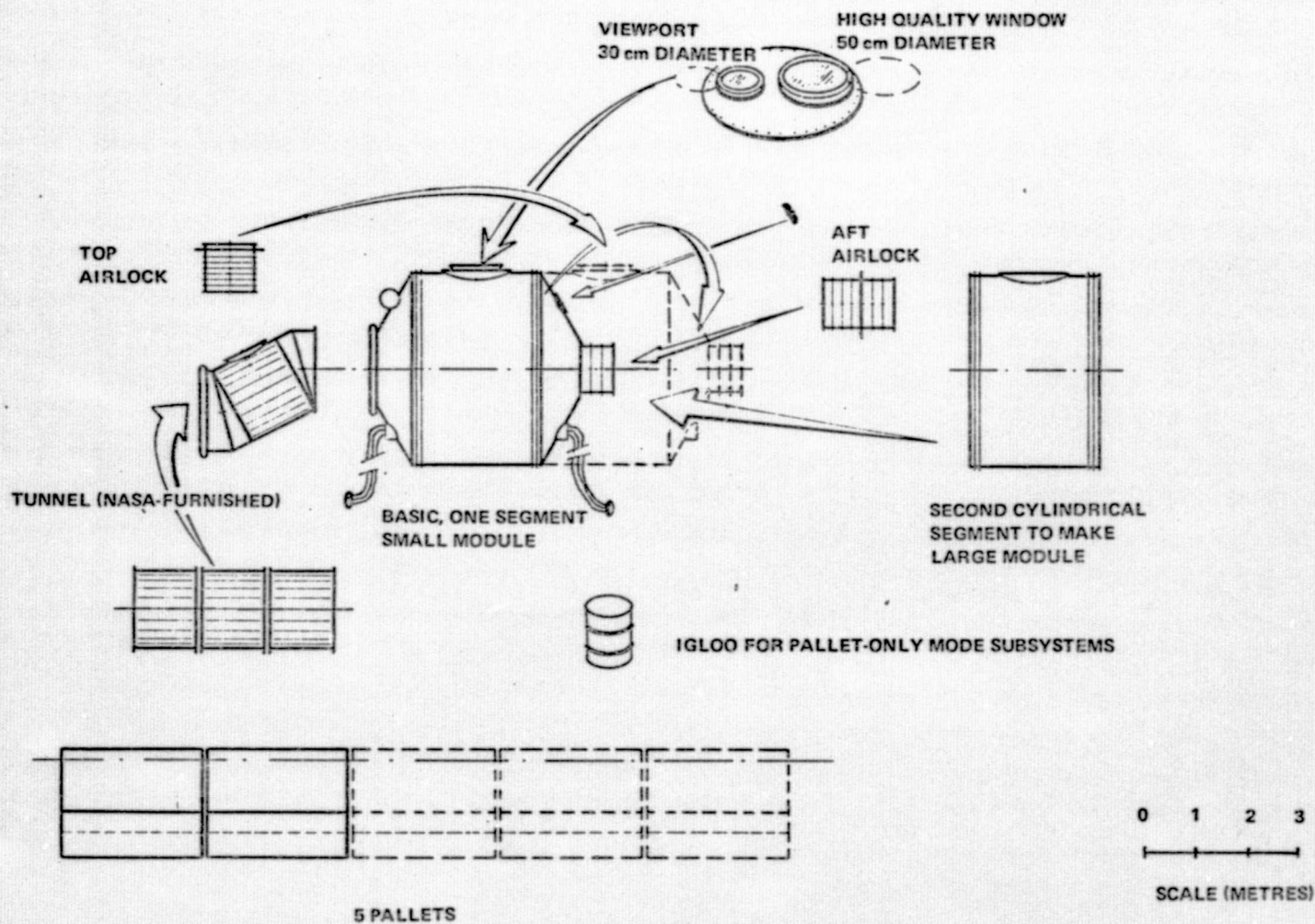


SECTIONAL VIEWS OF SPACELAB MODULE

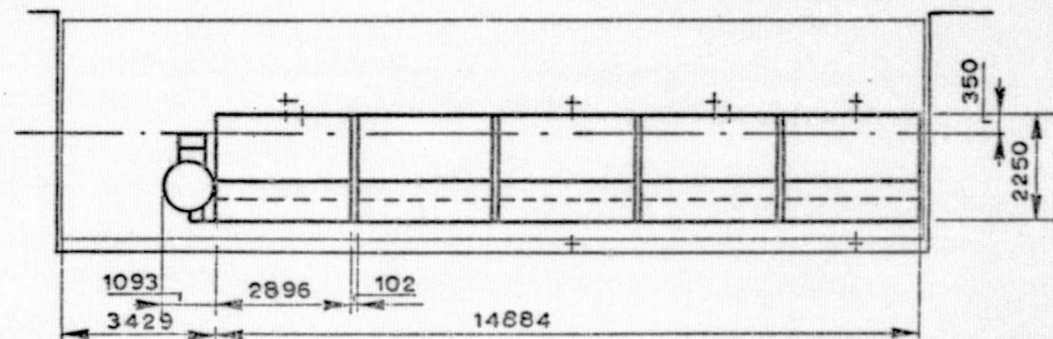
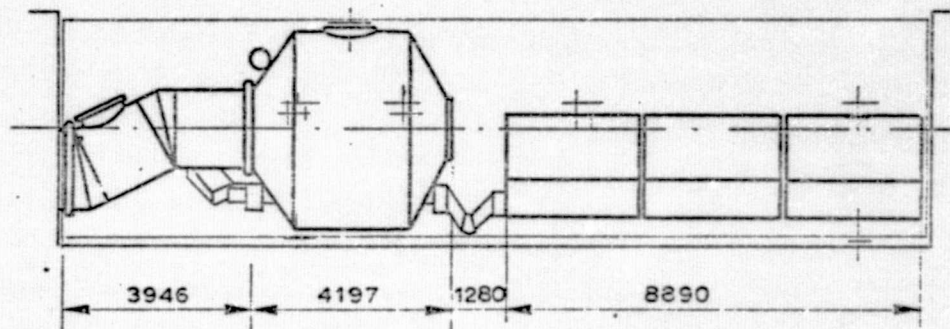
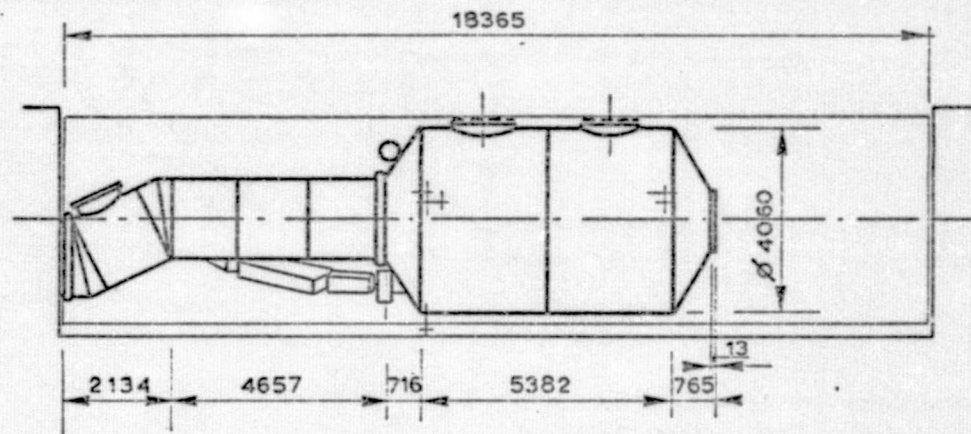


SPACELAB MODULARITY APPROACH

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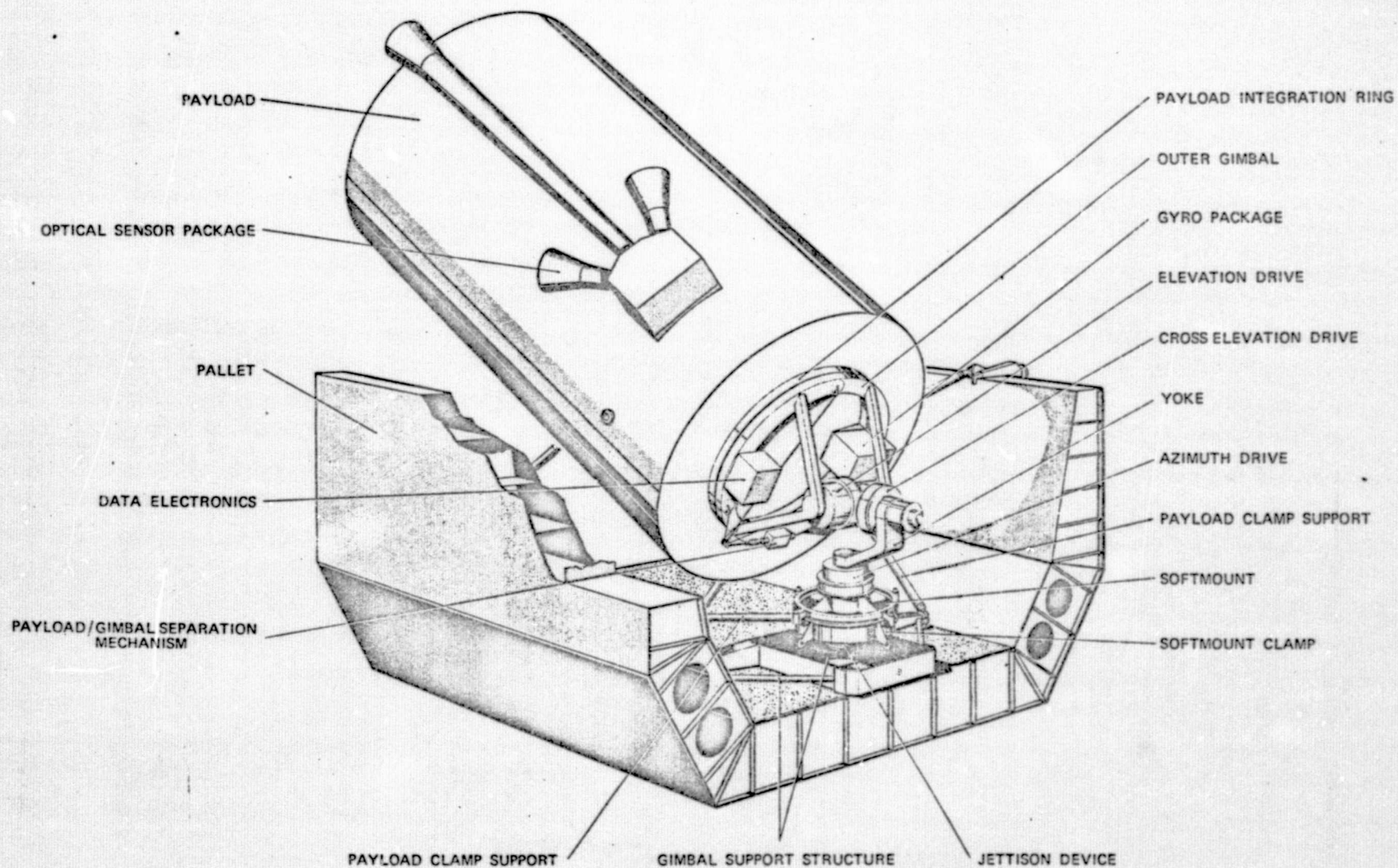


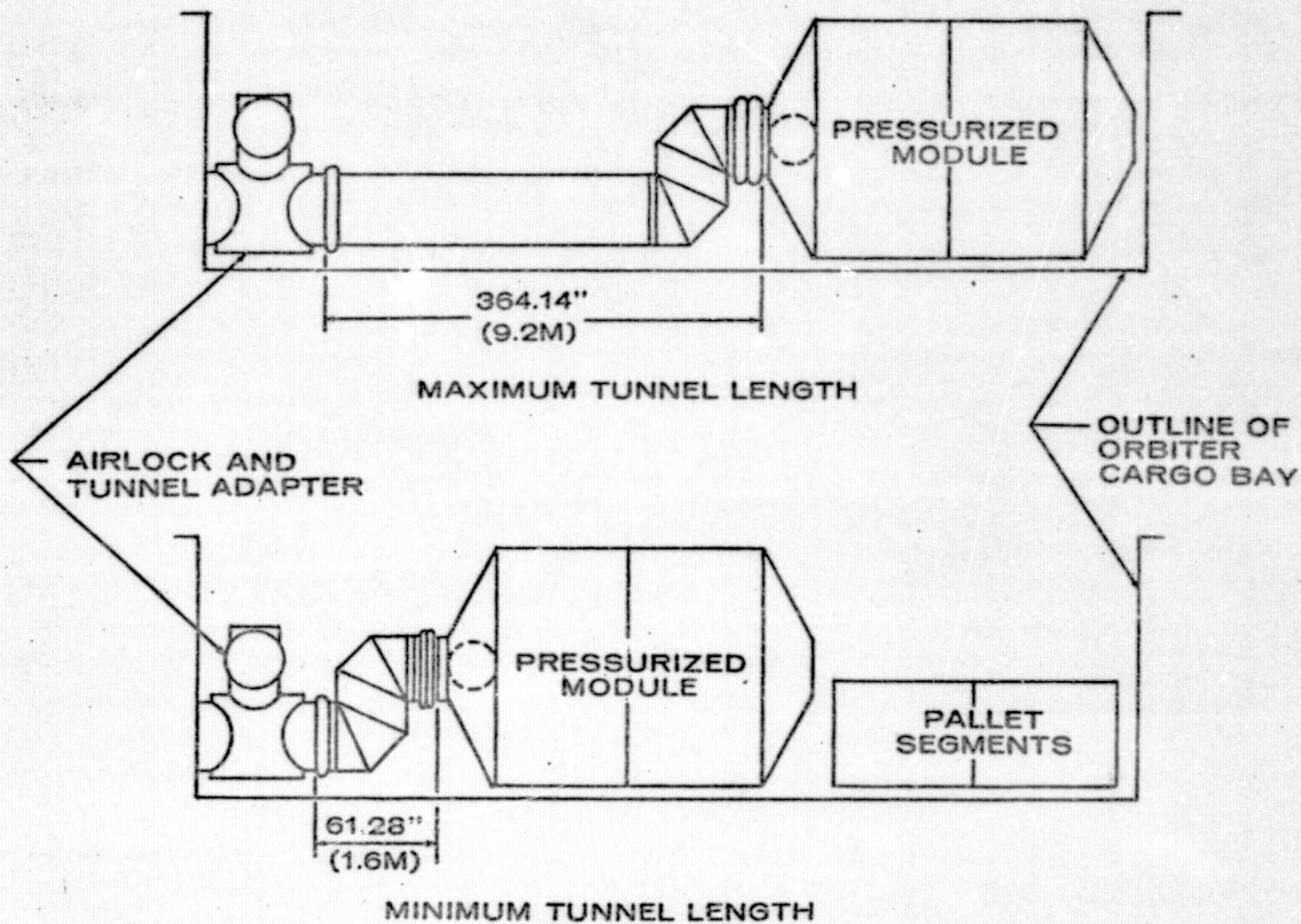
THREE TYPICAL SPACELAB FLIGHT CONFIGURATIONS



Date



**INSTRUMENT POINTING SUBSYSTEM**



TUNNEL CONFIGURATIONS FOR FORWARD AND AFT LOCATIONS OF SPACELAB

PROGRAMMATICS

SPACELAB PAYLOAD RESOURCES AND SERVICES SUMMARY

RESOURCES CONFIGURATION	WEIGHT (GOAL)	PRESSURIZED VOLUME	PALLET LENGTH	AVERAGE POWER (PRESENT ESTIMATES)	ENERGY*	DATA RECORDING	HEAT REJECTION
LONG MODULE	5500 KG	22.6M ³	- 0-6M POSSIBLE	2-3 KW	400 KWH	DIGITAL UP TO 30 MPS AT VARIOUS SPEEDS — VIDEO ANALOG RECORDER	3 KW AVIONICS AIRCOOLING
SHORT MODULE PLUS 6-9 M PALLET	5500 KG	8.0M ³	6-9 M 3M-12M POSSIBLE	2-3 KW	400 KWH		+ 1 KW CABIN AIRCOOLING
PALLET ONLY 9M/15M	8000 KG (15M) 9100 KG 9M	-	9M/15M 3M-15M POSSIBLE	4 KW	600 KWH		6.6 KW COLD PLATES

*CAPABILITY EXTENDIBLE IN ADD-ON KIT FORM CHARGEABLE TO THE PAYLOAD ALLOCATIONS OF WEIGHT AND VOLUME.

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REV. 1-22-76

SPACELAB SAFETY APPROACH

* 0 IDENTIFICATION AND DISPOSITION OF HAZARDS

FMEA/HAZARD ANALYSES

SAFETY-CRITICAL SYSTEMS

C&W PARAMETERS

REDUNDANCIES

CONTINGENCY PROCEDURES

EMERGENCY PROCEDURE TRAINING

To be modified

* 0 FIRE DETECTION AND SUPPRESSION

* 0 ISOLATION MASKS

0 CREW RESCUE

* 0 MATERIAL SELECTION REQUIREMENTS

SPACELAB SYSTEMS

PAYLOADS

* 0 EMERGENCY ACCESS/EGRESS

~~0 ECLS COMPONENTS FROM U.S.~~

* 0 SAFETY CONTROL DOCUMENTS

* 0 ~~EUROPEAN~~ CO-CONTRACTOR SAFETY REVIEW

RESPONSIBILITY

ESA

- FEASIBILITY STUDIES
- DESIGN AND DEVELOPMENT
- ENGINEERING MODEL (1978)
- FIRST FLIGHT UNIT (1979)
- TWO SETS GSE
- INITIAL SET OF SPARES
- SUSTAINING ENGINEERING THROUGH TWO FLIGHTS
- MAINTAIN PRODUCTION CAPABILITY ^{OF FOLLOW ON} FLIGHT UNITS
- *Integration of European Experiments*

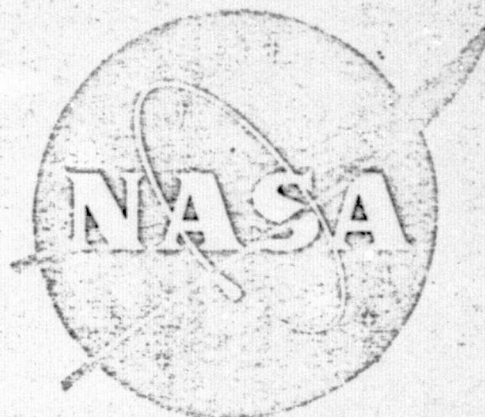
NASA

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- TECHNICAL SUPPORT
- MANAGERIAL SUPPORT
- TUNNEL DESIGN AND DEVELOPMENT
- OPERATIONAL ACTIVITY
 - CREW TRAINING
 - EXPERIMENT INTEGRATION
 - CHECK OUT
 - FLIGHT CONTROL
 - DATA ACQUISITION AND DISSEMINATION
 - REFURBISHMENT
- PROCUREMENT OF PRODUCTION UNITS

JOINT EFFORT

- REQUIREMENTS DETERMINATION
- CONCEPT SELECTION
- UTILIZATION
- CREWS

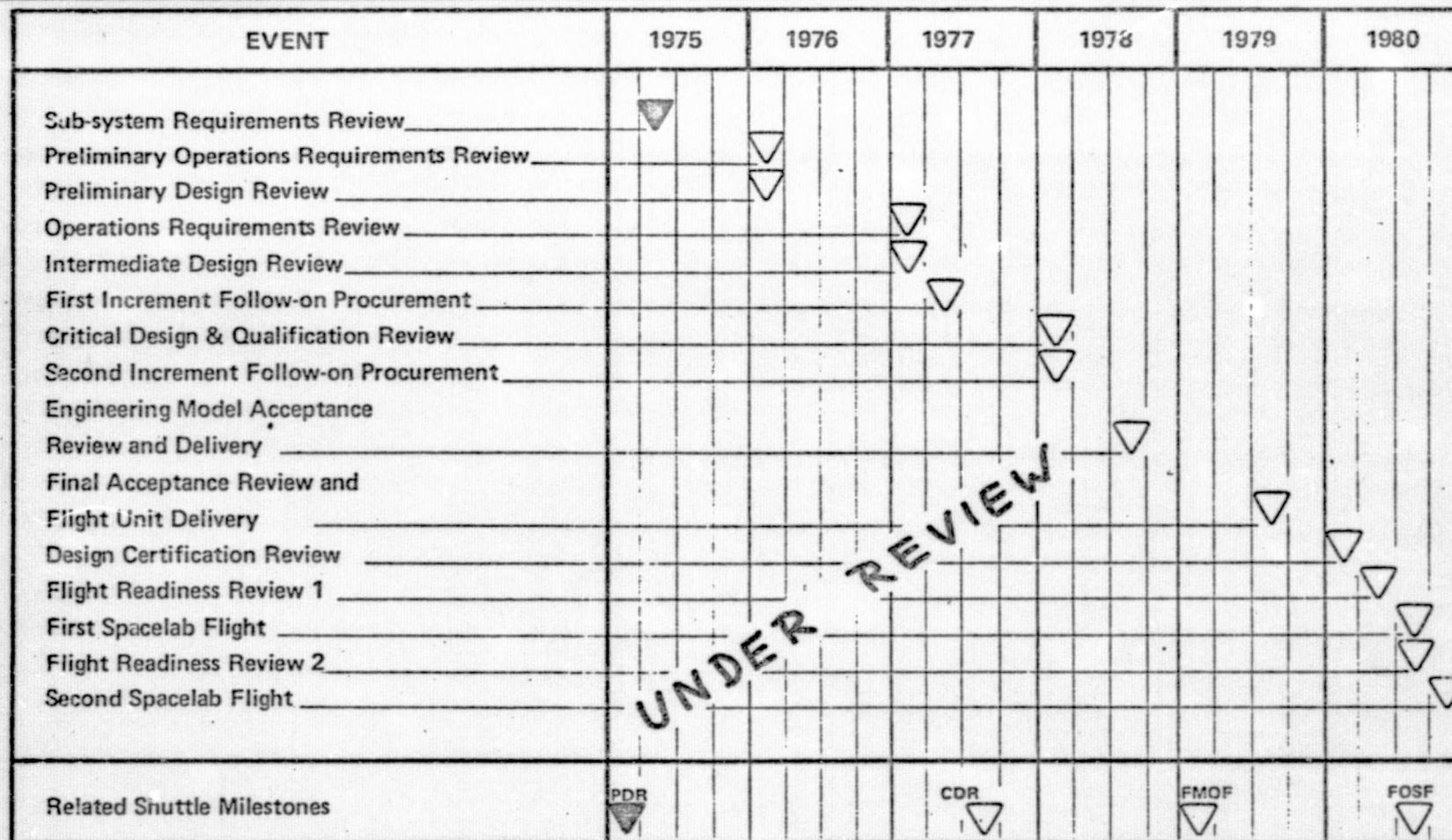


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REV. 8-12-75



esa

SPACELAB PROGRAMME MASTER WORKING SCHEDULE



FMOF = First Manned Orbital Flight
FOSF = First Operational Shuttle Flight

Agreed by NASA/ESA Spacelab
Programme Directors on
24 September 1975

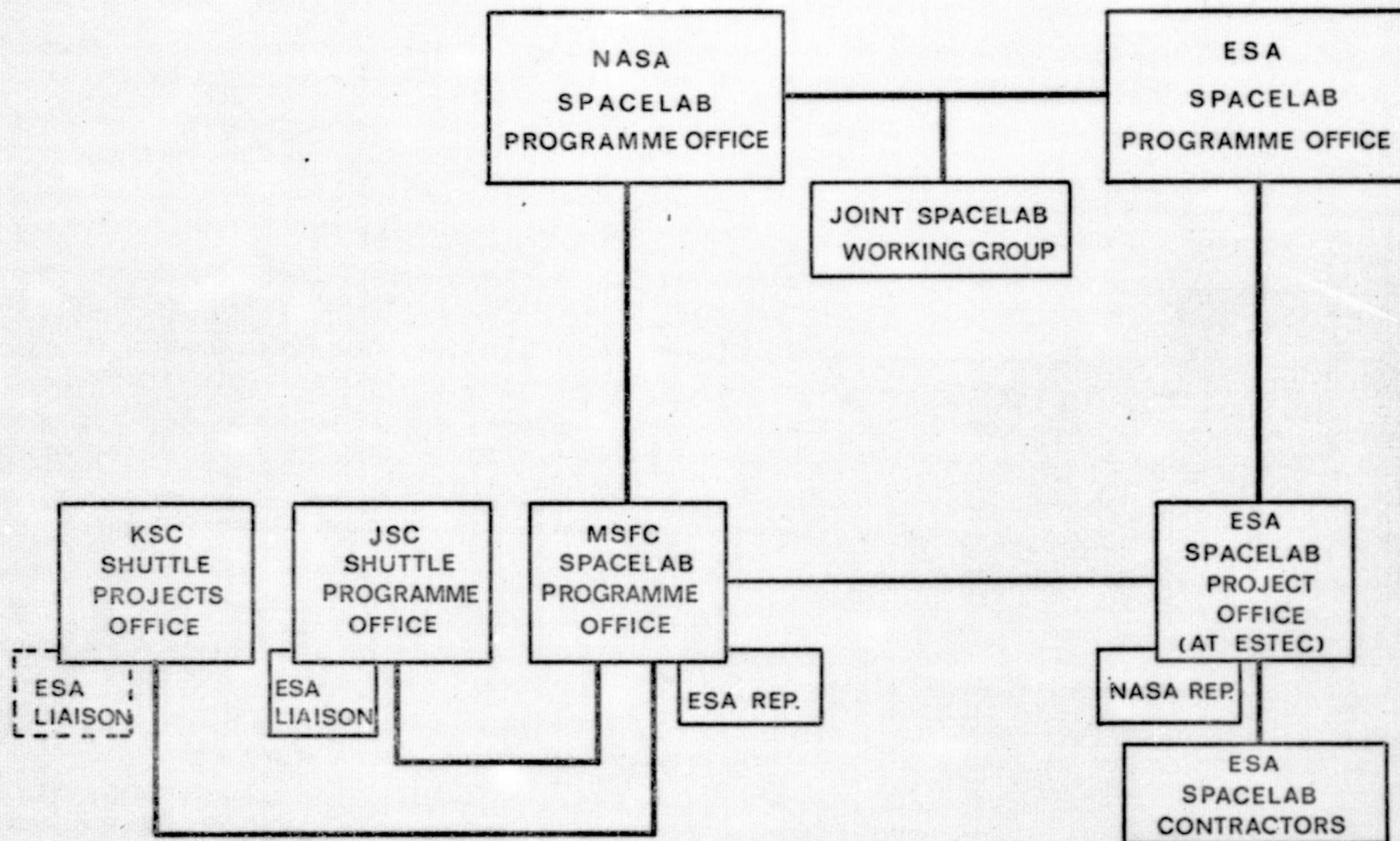
NEAR TERM SCHEDULED MILESTONES

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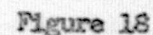
	1975												1976											
	J	F	M	A	M	J	J	A	S	O	N	D	J	F	M	A	M	J	J	A	S	O	N	D
Austria joins Spacelab Programme		▼																						
Prime developm. contract IPS contract									▼ signed					▼ ATP										
Programme Reviews						▼ SRR										PDR-A ▼			▼ PORR			▼ PDR-B		
Hardware Soft Mockup Hard Mockup Develop. Units Integr. Building Engineering Model						▼ completed			▼ started		▼ start pallet	▼ externally completed				▼ start integration			▼ completed					
Documentation signed Programme Requ. Doc. SPAH (Spacelab Payload Accommodation Handbook) Orbiter to Spacelab ICD.									▼							▼ draft			▼ final					
ASSESS I flown ESA proposal for ASSESS II						▼			▼															
First Payload Exper. objectives agreed NASA AFO. ESA Payload selection. Agreement on experiments.						▼								▼				▼		▼				
Follow-on Production NASA requ. for cost estim. ESA cost estimates NASA requ. for proposal								▼						▼									▼	



SPACELAB PROGRAMME MANAGEMENT ORGANISATION



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SPACELAB INDUSTRIAL TEAM ORGANISATION

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A - AUSTRIA
B - BELGIUM
CH - SWITZERLAND
D - GERMANY
DK - DENMARK
E - SPAIN
F - FRANCE
GB - GREAT BRITAIN
I - ITALY
NL - NETHERLANDS
US - UNITED STATES

EUROPEAN SPACE AGENCY (ESA / ESTEC)

Overall Project Direction and Control
Coordination with NASA and Users

CUSTOMER

DORNIER

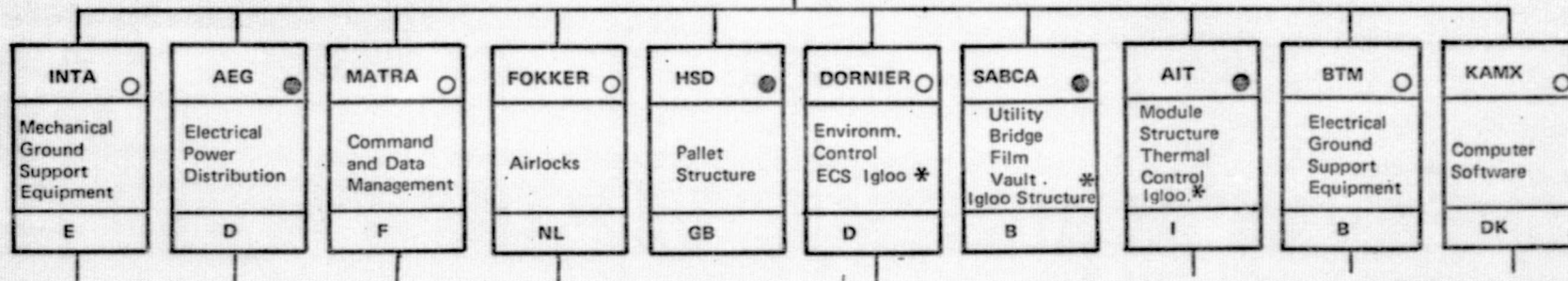
Instrument
Pointing
System

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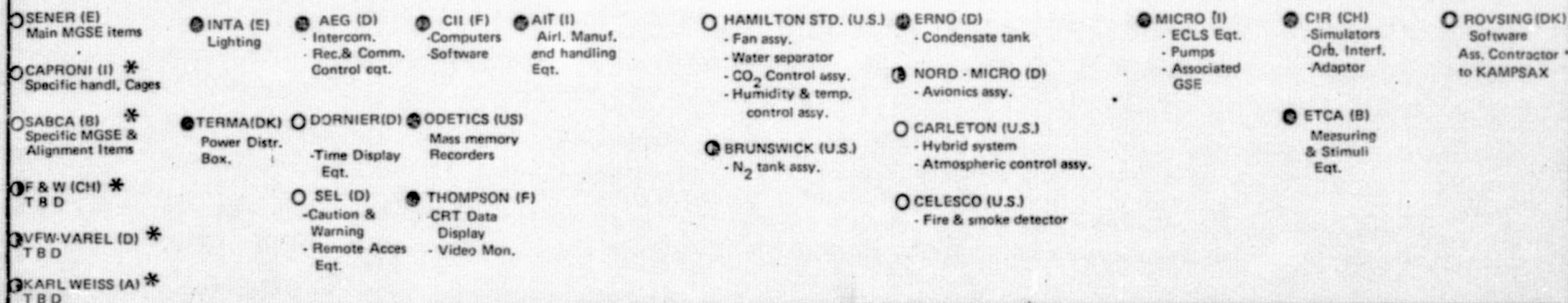
VFW - FOKKER / ERNO

Project Mgmt
System Eng. / Product Assurance
Crew habitability
Soft/Hard mockup
Integr./checkout
Operations
Igloo Thermal Control *

PRIME
CONTRACTOR



CO-CONTRACTORS



SUB-CONTRACTORS

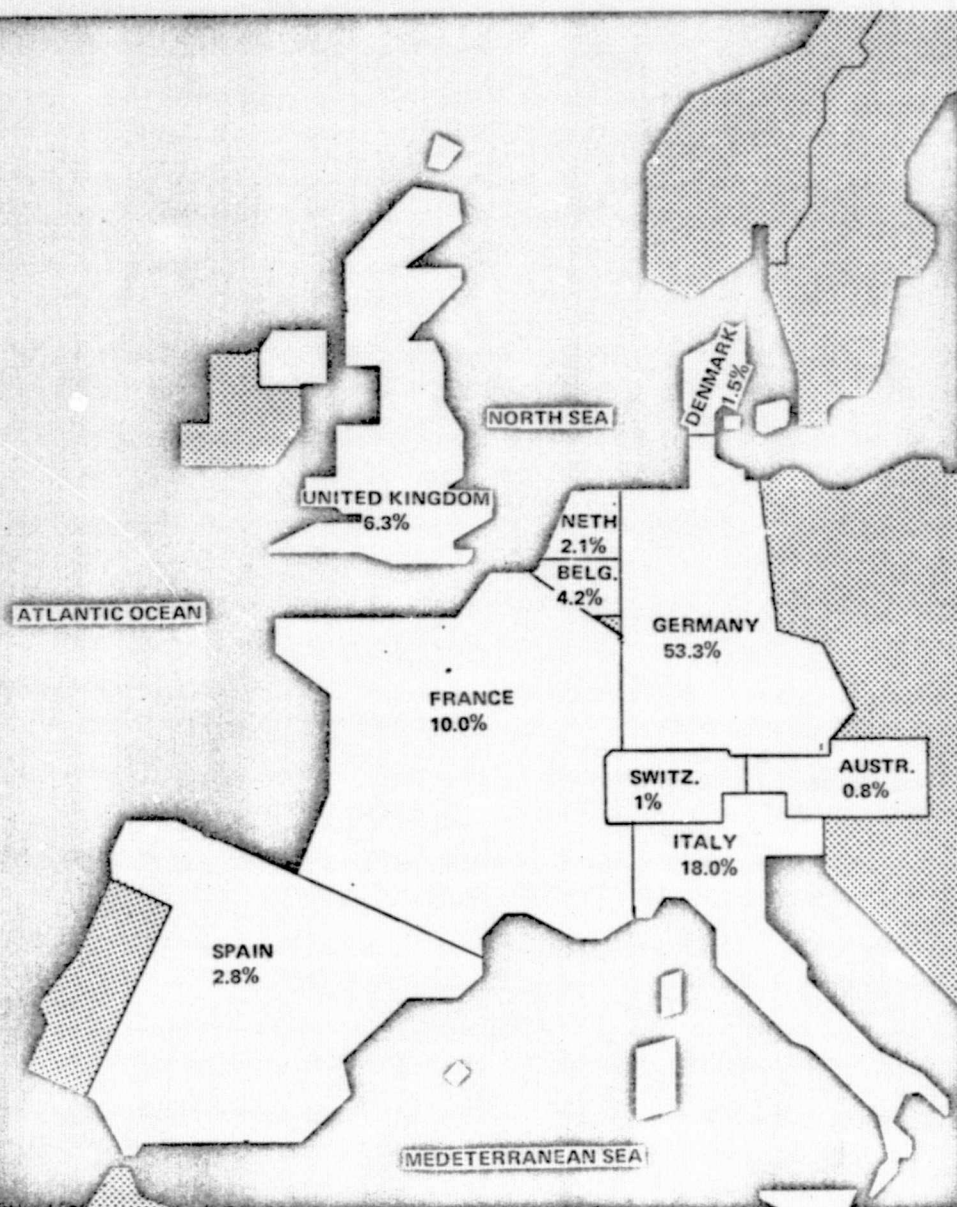
* PENDING DELETION/ADDITION.

● = FIXED PRICE
○ = COST REIMBURSEMENT
⊙ = T.B.D.



SPACELAB PROGRAMME FUNDING

752495



ESA SPACELAB BUDGET ALLOCATION

	MAU *
Definition Studies	12
Contract Baseline	217
IPS	18
Special Studies, Modifications and Reserves	88
Support and Internal Cost	61
Total	396
Approx. Million US \$	515

PAYMENTS

MAU*			
1973	1974	1975	1976 (PLANNED)
9.2	15.7	50.0	84.7

* MID 1975 PRICES
1 AU \cong 1.30 US \$

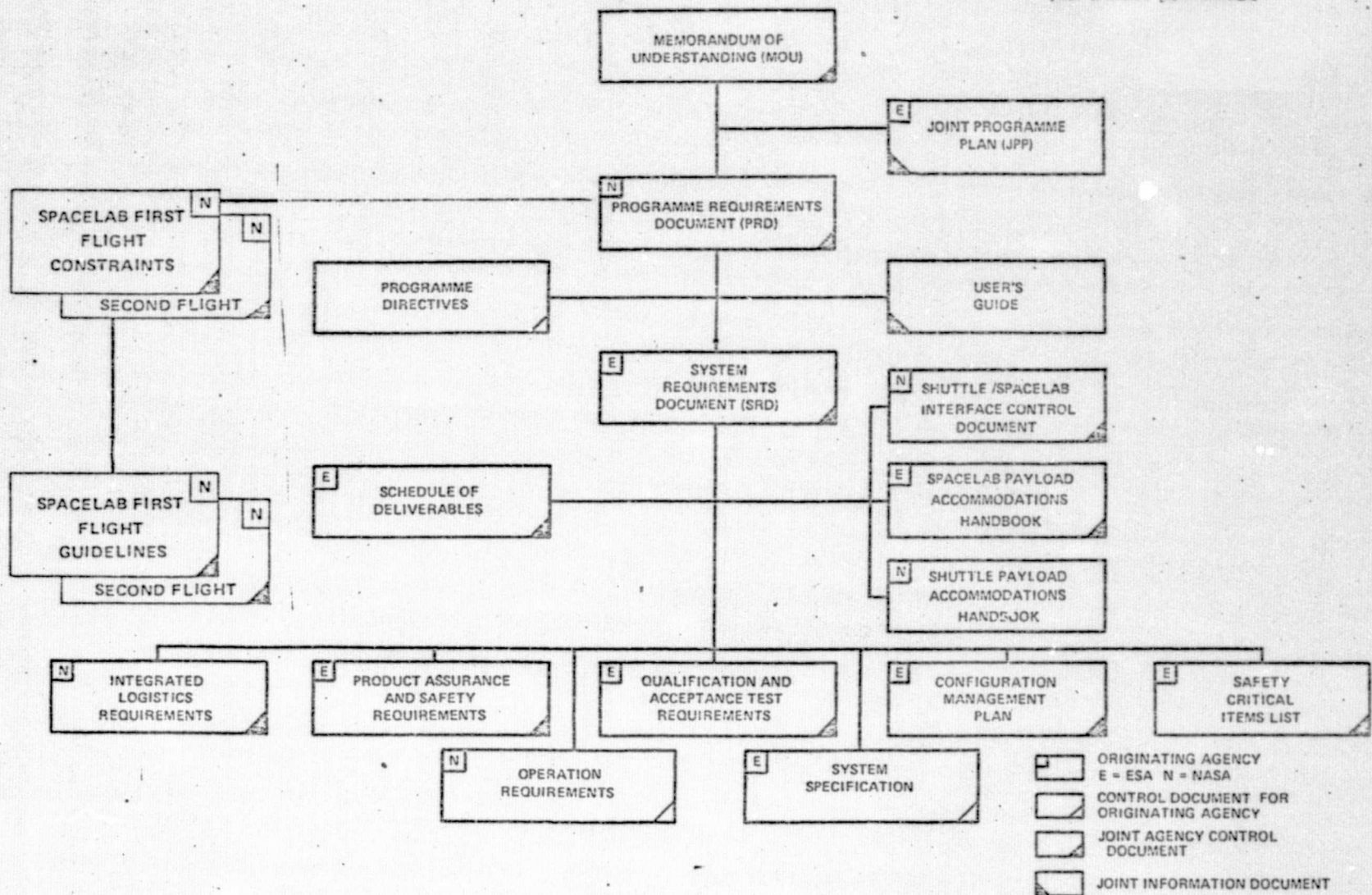


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NASA Funding

PRINCIPAL SPACELAB DOCUMENTATION

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PAYLOAD INTEGRATION/OPERATIONS

USER PARTICIPATION

INDIVIDUAL USER

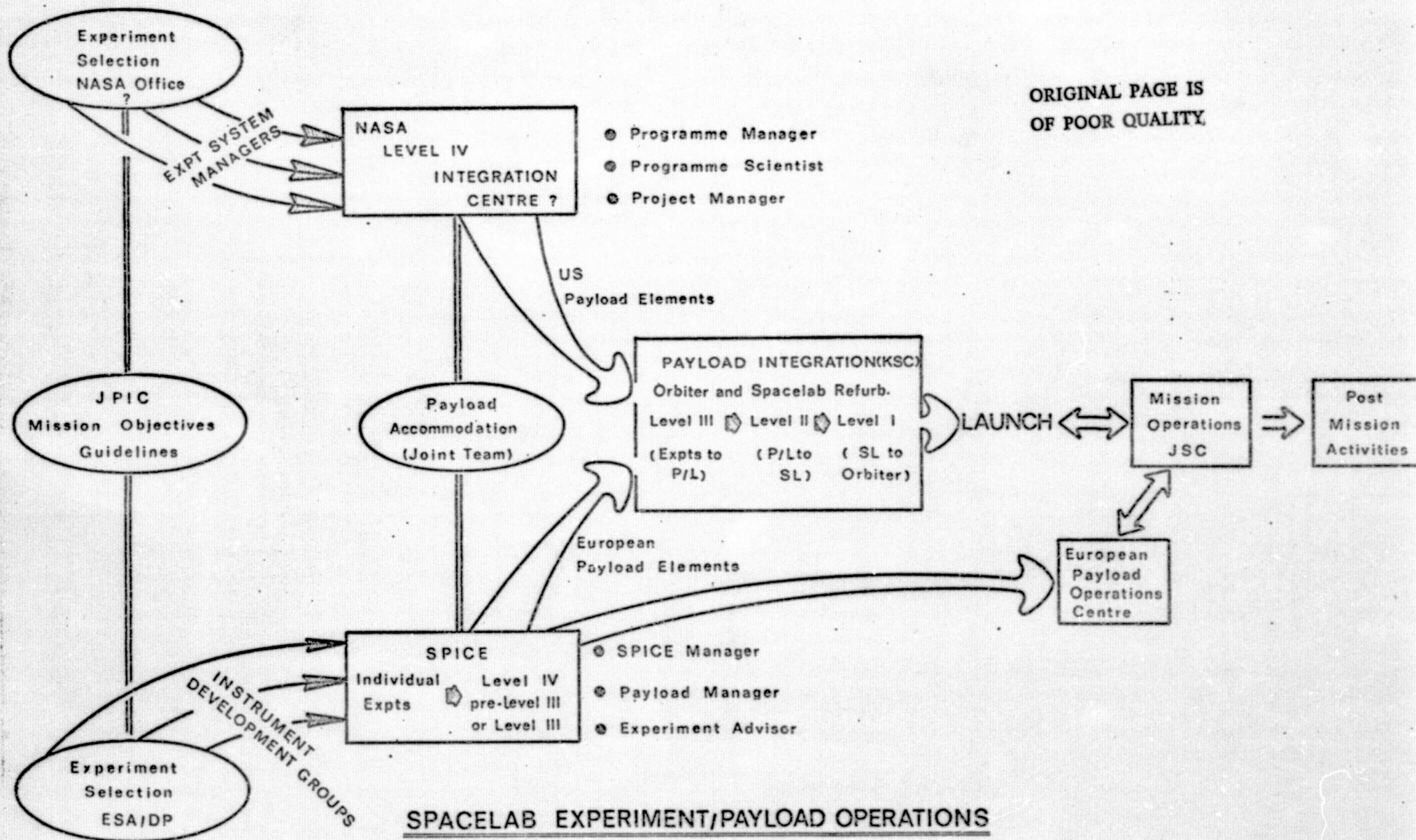
- ① INITIATES PARTICIPATION THROUGH PROPOSAL RESPONSE TO ANNOUNCEMENT OPPORTUNITY
- ② HAS CHOICE OF DEGREE OF PARTICIPATION, EXPERIMENT DEVELOPER TO DATA USER
- ③ HAS FIRM FUNCTIONS AND RESPONSIBILITIES DURING THE EXPERIMENT LIFE CYCLE
- ④ PARTICIPATES IN MISSION OPERATIONS AS PAYLOAD SPECIALIST OR AS EXPERIMENT CONTROLLER
- ⑤ RESPONSIBLE FOR DATA REDUCTION AND PUBLICATION

USER ORGANIZATION

- ① PROVIDES FOCUS FOR PLANNING AND DEVELOPMENT OF MAJOR LABORATORIES
- ② PROVIDES MAJOR INTERFACE WITH INDIVIDUAL EXPERIMENTER
- ③ ASSUMES OVERALL RESPONSIBILITY FOR EXPERIMENT DEVELOPMENT, INTEGRATION AND DATA REDUCTION
- ④ COORDINATES PAYLOAD CONTROL CENTER AND EXPERIMENT GROUND SUPPORT ACTIVITIES
- ⑤ ORGANIZATIONS: GOVERNMENT AGENCY, UNIVERSITY, INDUSTRY

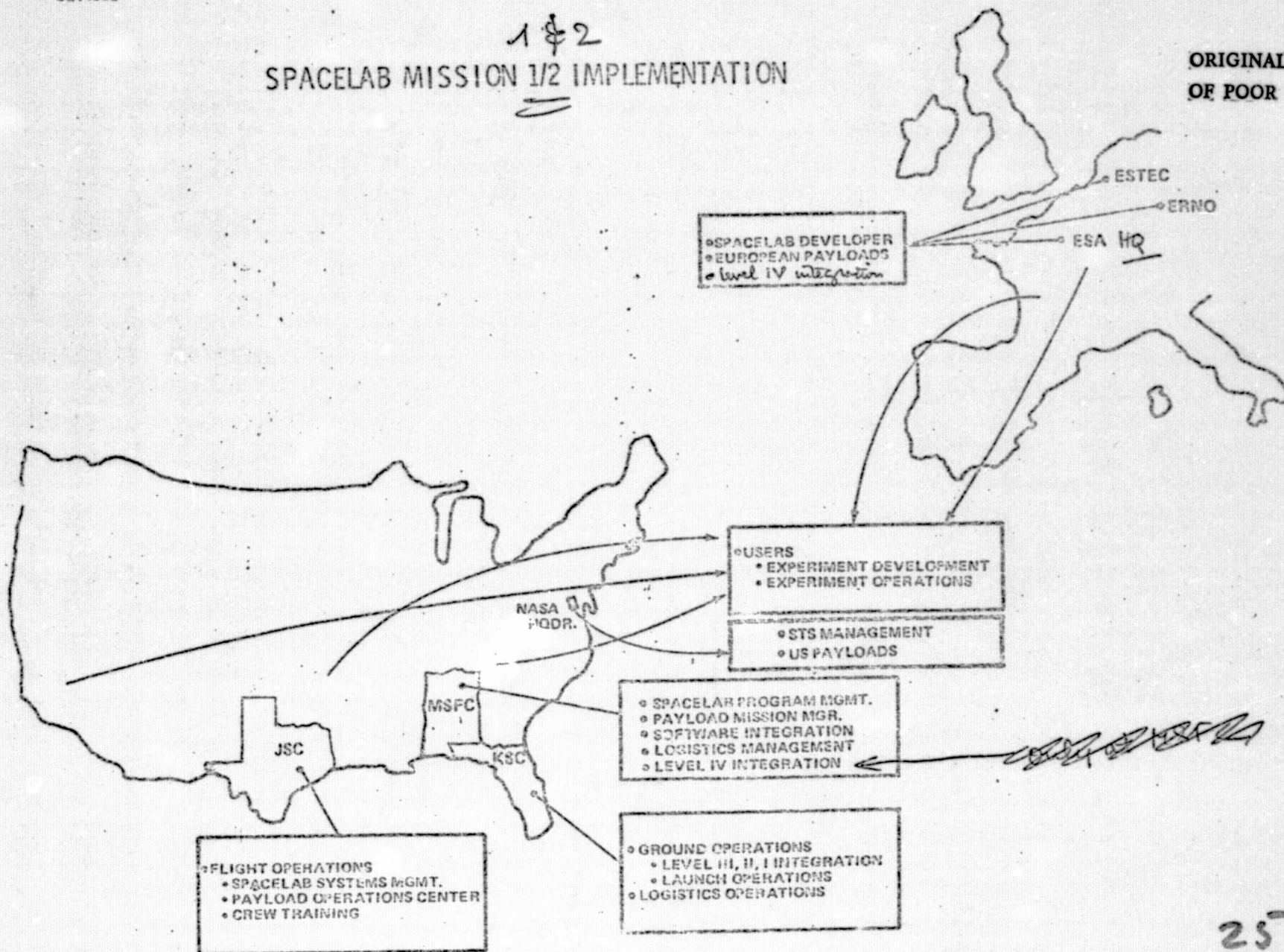
SPACELAB

- ① PROVIDES USER WITH EXPERIMENT SUPPORT RESOURCES
- ② CONTROLS EXPERIMENT SAFETY AND SPACELAB/EXPERIMENT INTERFACES

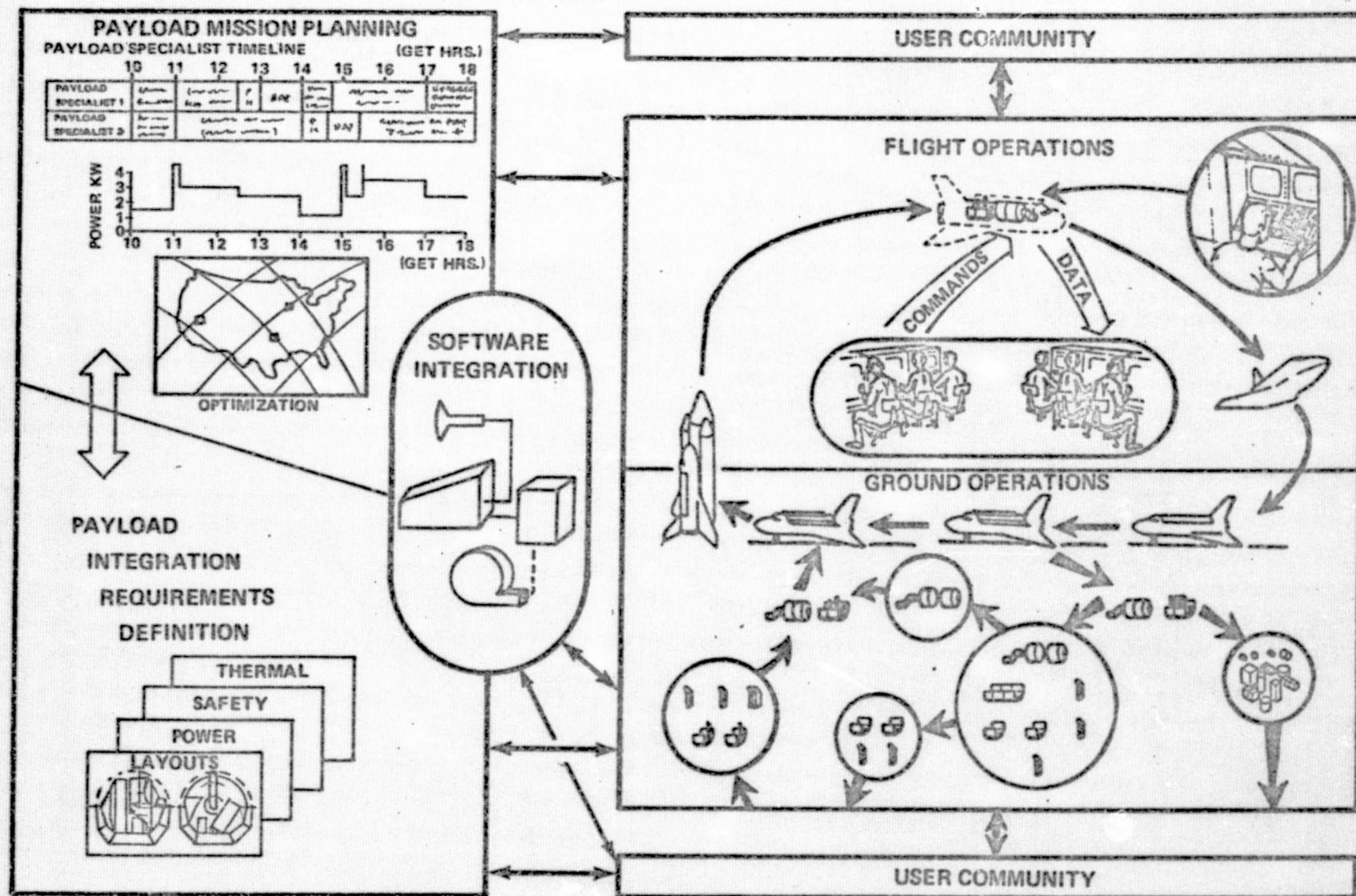


1 & 2
SPACELAB MISSION 1/2 IMPLEMENTATION

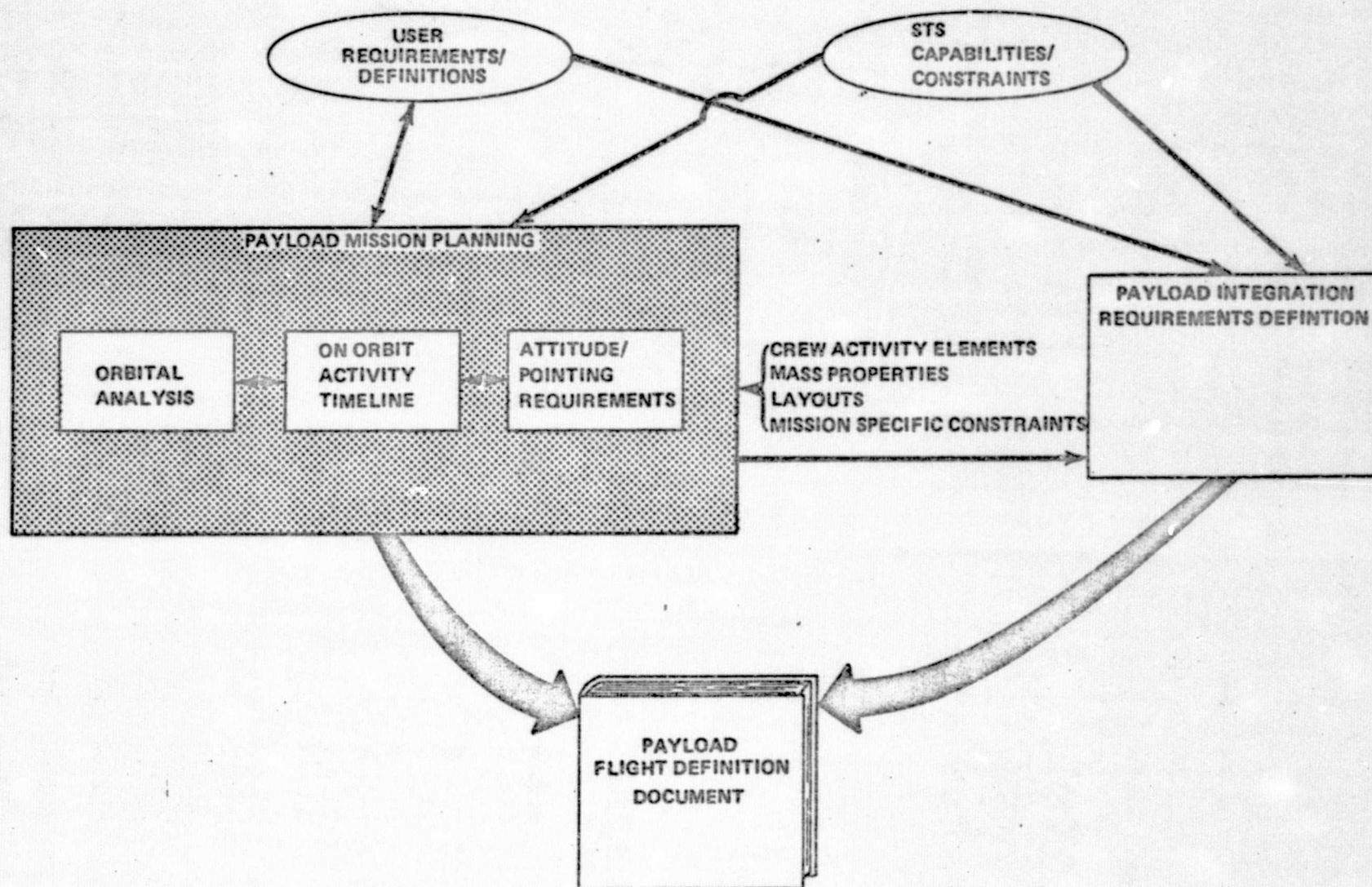
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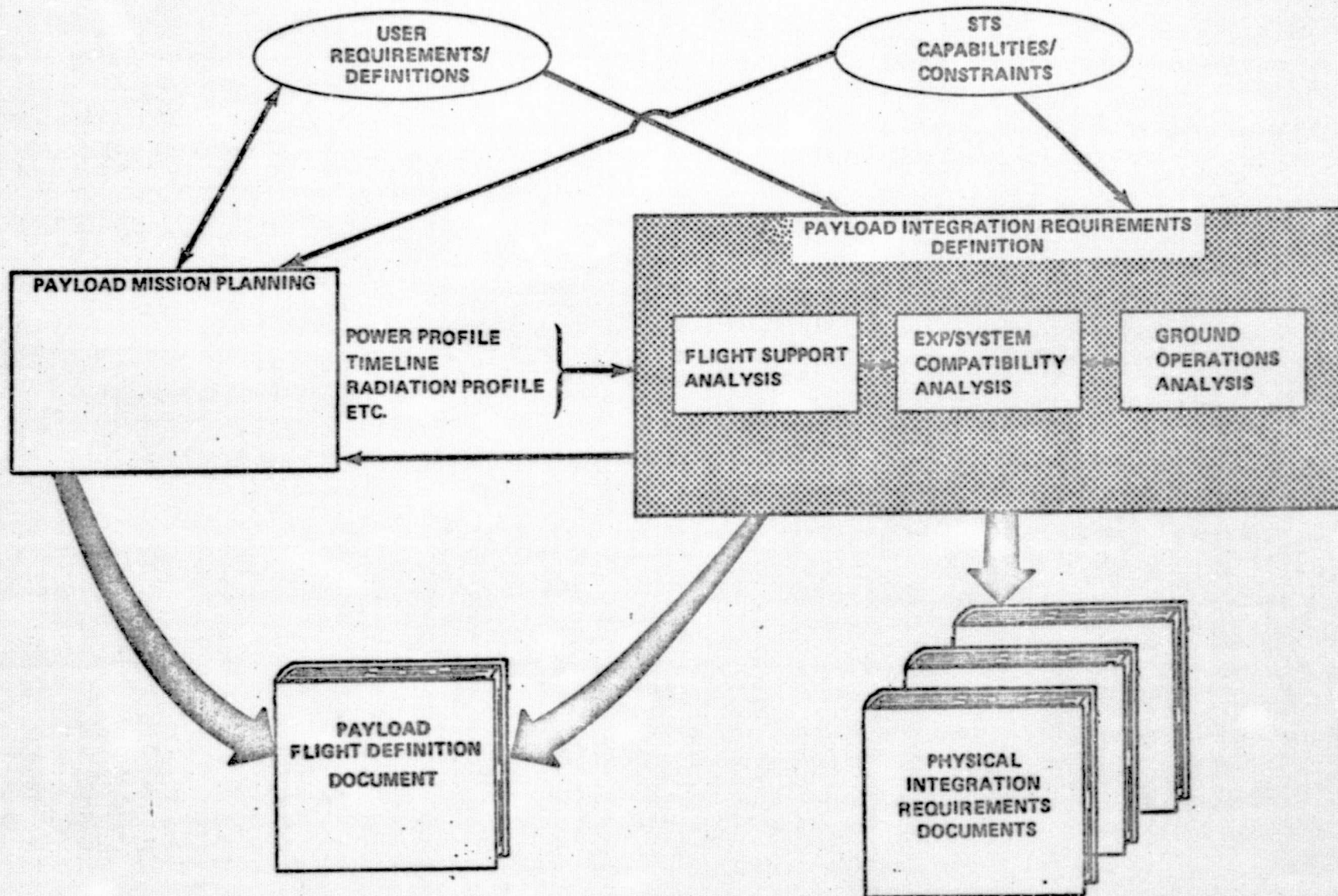
SPACELAB OPERATIONS OVERVIEW



PAYLOAD MISSION PLANNING ELEMENTS/INTERFACES

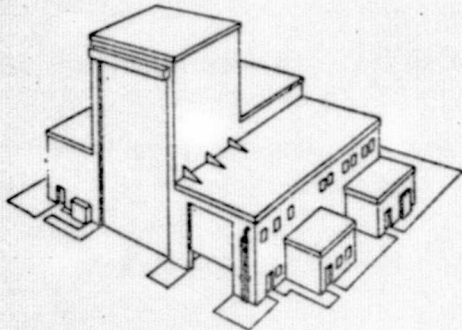
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PAYLOAD INTEGRATION REQUIREMENTS DEFINITION ELEMENTS/INTERFACES

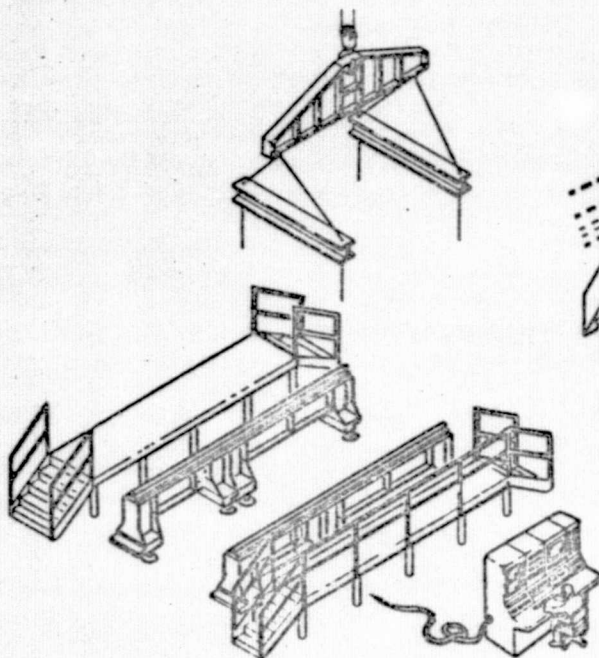


GROUND OPERATION ACTIVITIES

● LOGISTICS



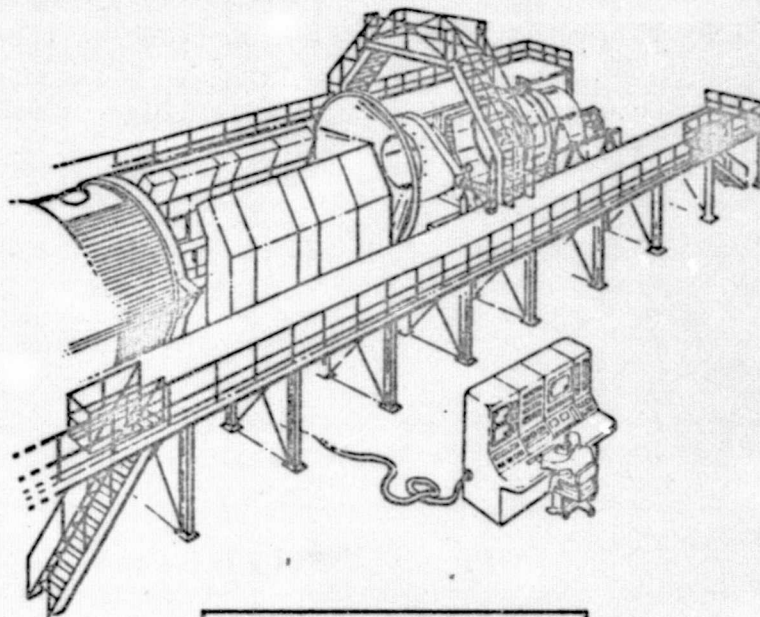
● FACILITY SUPPORT



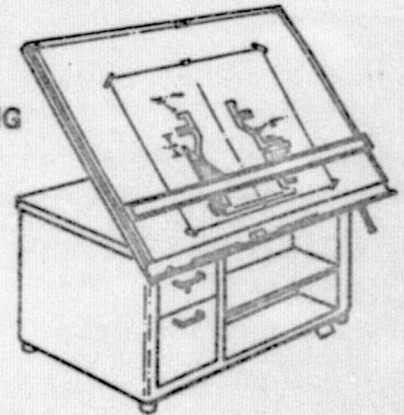
● SUPPORT EQUIPMENT PROVISIONING

● SUSTAINING ENGINEERING

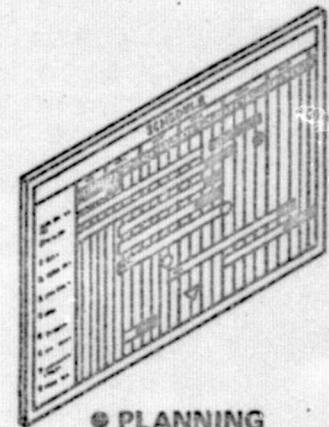
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● PHYSICAL INTEGRATION



● OPERATION SUPPORT



● PLANNING & SCHEDULING



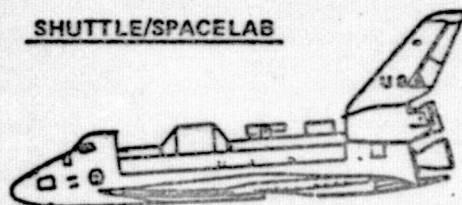
● SURVEILLANCE

SPACELAB PROCESSING & LEVELS OF INTEGRATION

- STAGING - PREPARATION OF EXPERIMENT ELEMENTS, AFT BULKHEADS AND SPECIAL EXPERIMENT SECTIONS FOR INTEGRATION.
- LEVEL IV - INTEGRATION AND CHECKOUT OF EXPERIMENT EQUIPMENT WITH INDIVIDUAL EXPERIMENT MOUNTING ELEMENTS (e.g. RACKS AND PALLET SEGMENTS).
- LEVEL III - COMBINATION, INTEGRATION AND CHECKOUT OF ALL EXPERIMENT MOUNTING ELEMENTS (e.g. RACKS, RACK SETS AND PALLET SEGMENTS) WITH EXPERIMENT EQUIPMENT ALREADY INSTALLED, AND OF EXPERIMENT AND SPACELAB SOFTWARE.
- LEVEL II - INTEGRATION AND CHECKOUT OF THE COMBINED EXPERIMENT EQUIPMENT AND EXPERIMENT MOUNTING ELEMENTS (e.g. RACKS, RACK SETS AND PALLET SEGMENTS) WITH THE FLIGHT SUBSYSTEM SUPPORT ELEMENTS (i.e. BASIC MODULE, IGLOO) AND EXTENSION MODULES, WHEN APPLICABLE.
- LEVEL I - INTEGRATION AND CHECKOUT OF THE SPACELAB AND ITS' PAYLOADS WITH THE SHUTTLE ORBITER, INCLUDING THE NECESSARY PREINSTALLATION TESTING WITH SIMULATED INTERFACES.
- POST FLIGHT PROCESSING -
LANDING AND SAFING OPERATIONS, REMOVAL FROM ORBITER, DISASSEMBLY, MAINTENANCE AND REVERIFICATION OF SPACELAB ELEMENTS AND EXPERIMENTS.

FLIGHT OPERATIONS

SHUTTLE/SPACELAB



TDRSS



STS FUNCTIONS

- COMMAND OF FLIGHT
- FLIGHT SAFETY
- ORBITER / SPACELAB
RESOURCES MANAGEMENT
- RMS OPERATION
- EVA

PAYLOAD FUNCTIONS

- SETUP EXPERIMENT EQUIPMENT
- OPERATE EXPERIMENTS
- OBSERVE RESULTS
- ALTER EXPERIMENT OPERATION TO
MAXIMIZE SCIENCE RETURN
- MAINTAIN EXPERIMENT EQUIPMENT

GROUND SUPPORT

STS FUNCTIONS

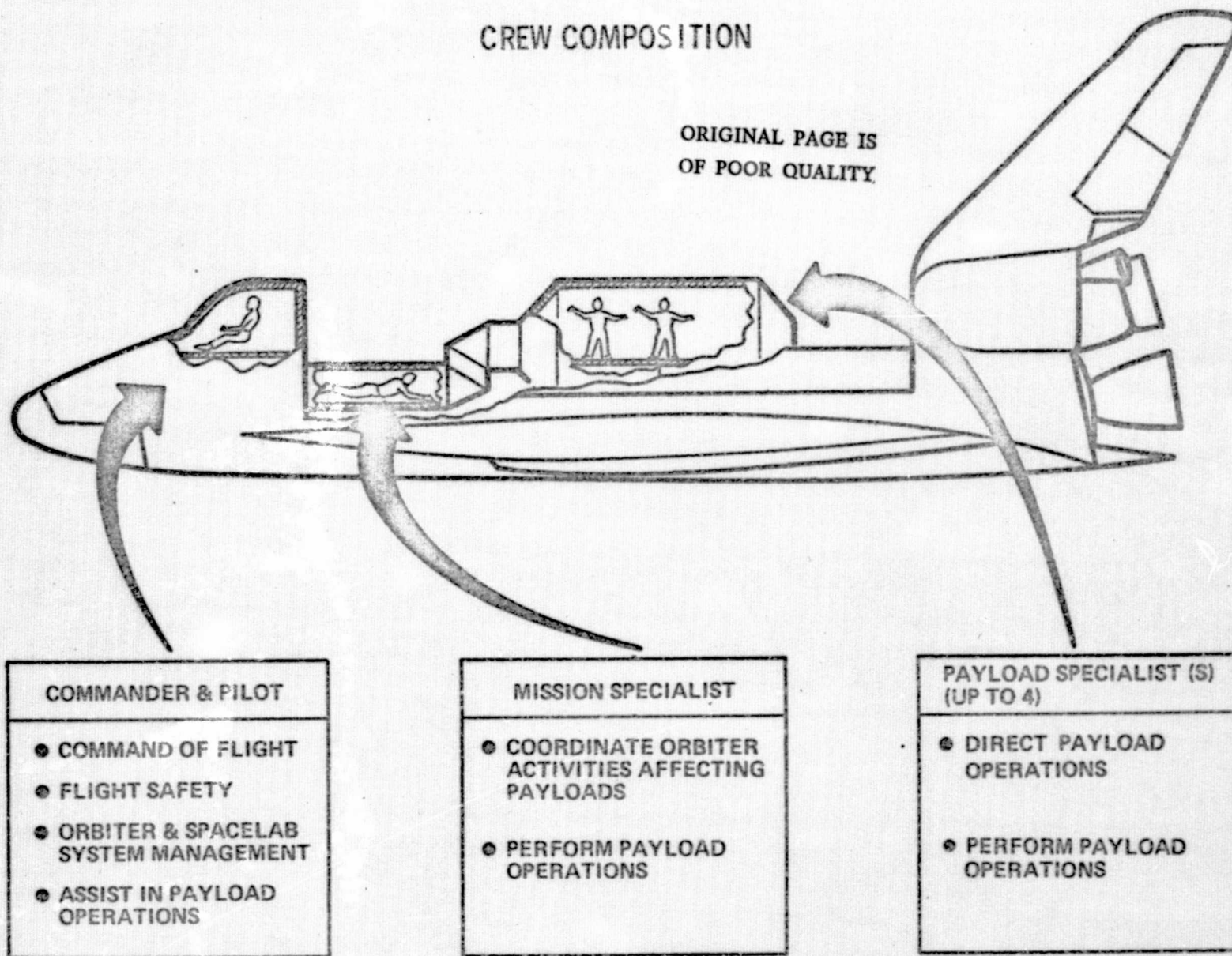
- SHUTTLE OPERATION
- SPACELAB RESOURCES MANAGEMENT
SUPPORT
- FLIGHT PLAN INTEGRATION
- DATA & COMMUNICATIONS MANAGEMENT
- ORBITER/SPACELAB CONTINGENCY
ANALYSIS

PAYLOAD FUNCTIONS

- GROUND-BASED USER SUPPORT TO PAYLOAD
SPECIALIST
- COMMAND FUNCTIONS TO ENHANCE P/L
SPECIALIST TIME AND SCIENCE RETURN
- SCIENCE DATA MANAGEMENT
- REAL TIME PAYLOAD ACTIVITY RESCHEDULING
- PAYLOAD CONTINGENCY ANALYSIS

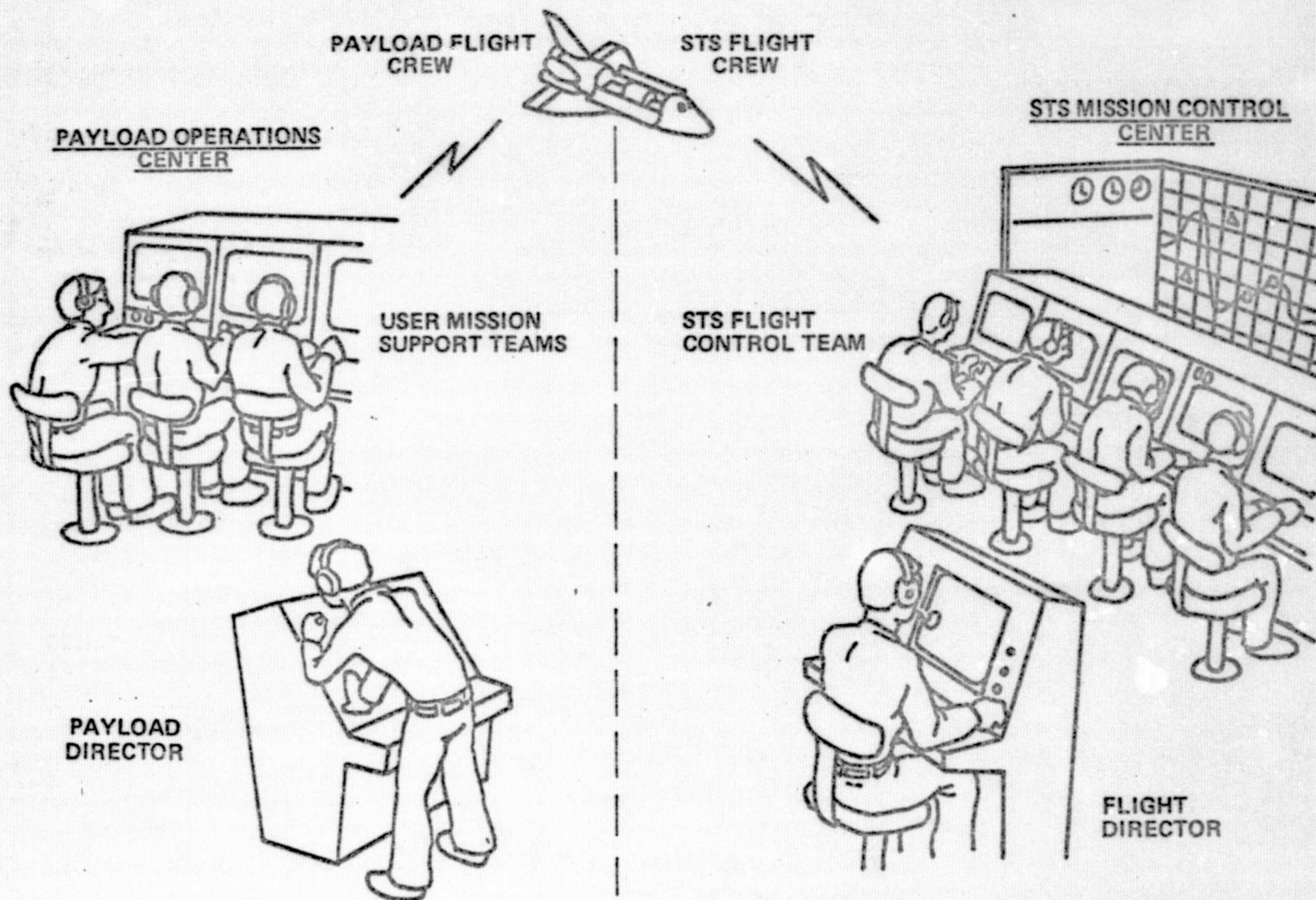
CREW COMPOSITION

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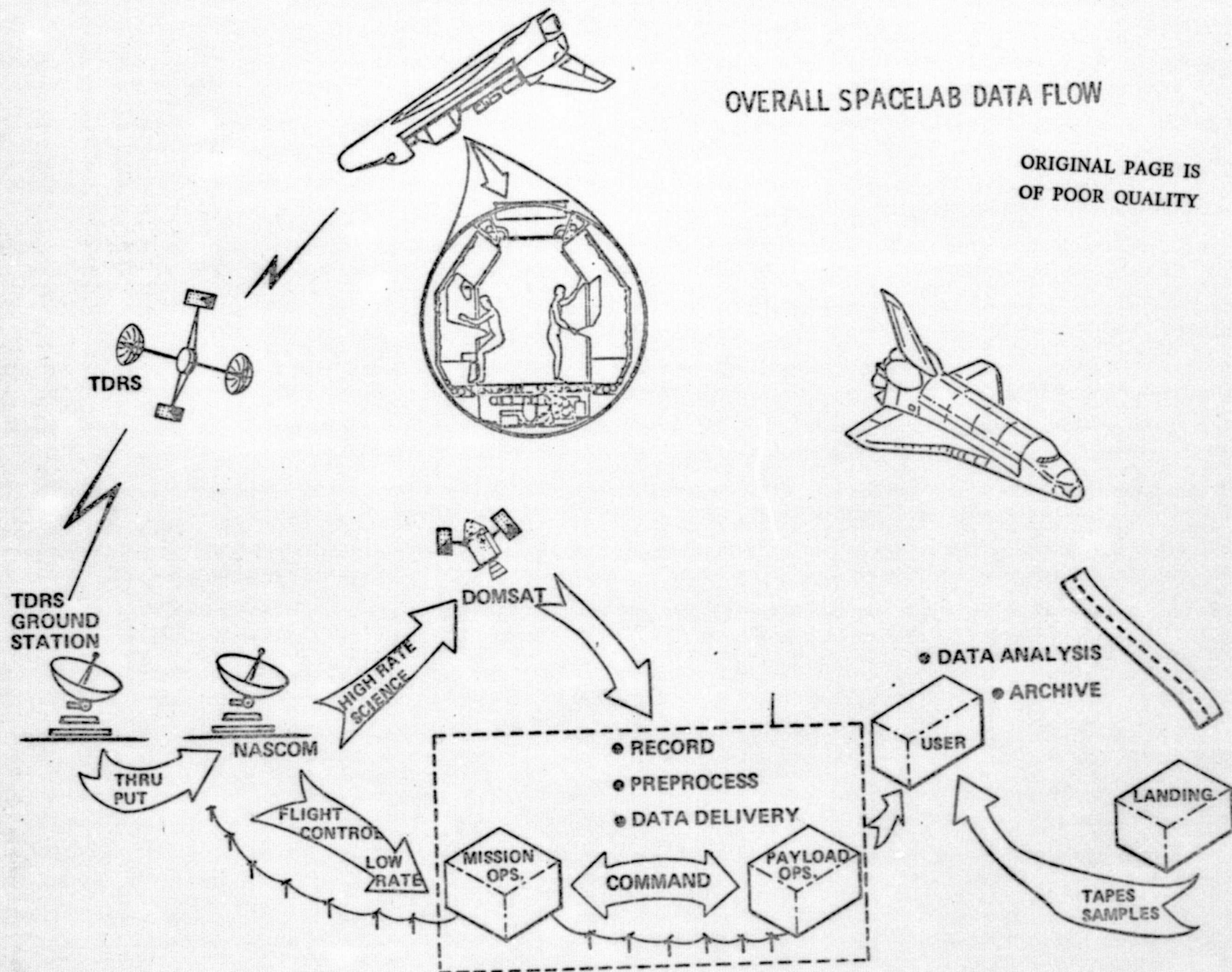
GROUND SUPPORT ORGANIZATION AND INTERFACES

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OVERALL SPACELAB DATA FLOW

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SPACELAB FOLLOW - ON PROCUREMENT

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- 0 ESA PLANS FOR FOLLOW-ON PROCUREMENT BY NASA
 - tooling design and development
 - production line (s) set up and continuation
 - organizational and management arrangements
- 0 COST ESTIMATES PREPARED BY INDUSTRY AND ESA ARE CURRENTLY EVALUATED BY NASA
- 0 FOP PLANNED EVENTS

